Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1950 TECHNOLOGY DEPT.

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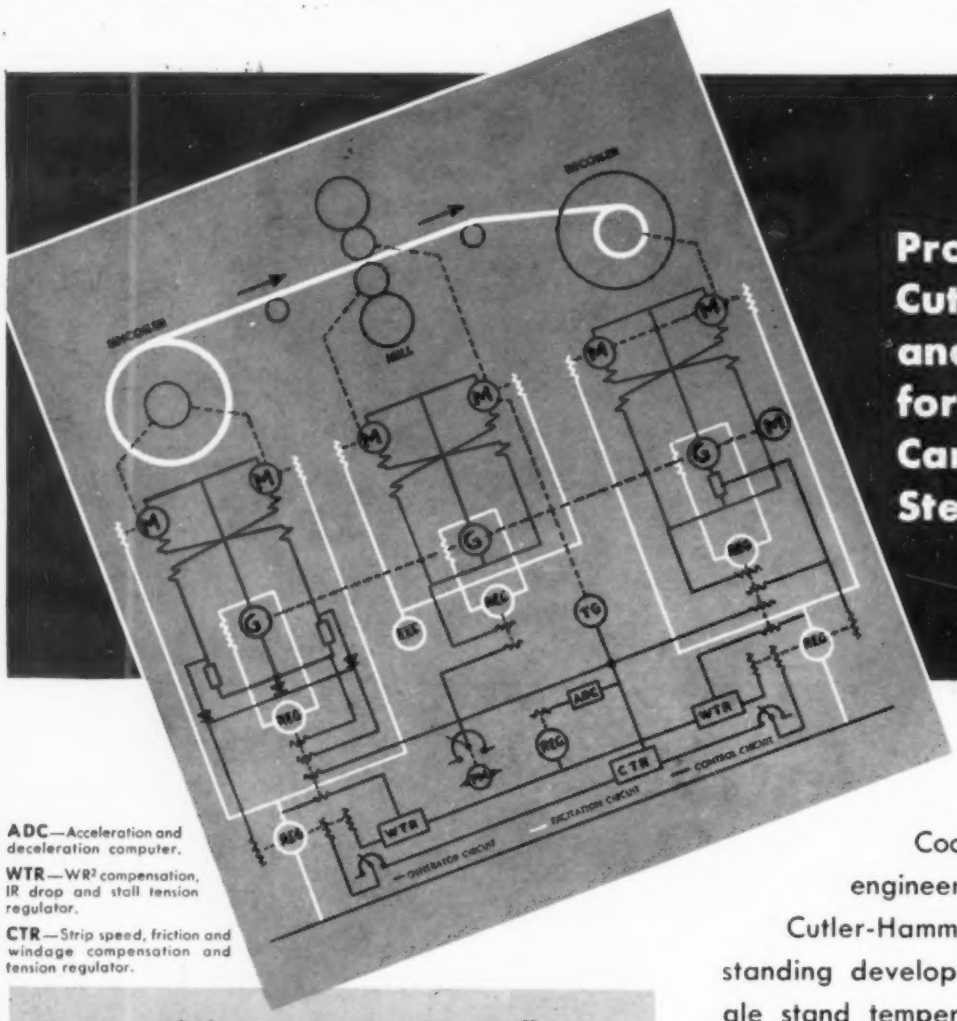
Mesta Patented Flying Shear and Four-High Universal Stand of a Mesta 80" Continuous Hot Strip Mill

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Modern high speed temper mill drive maintains accurate tension at 2500 F.P.M.



Produced by Cutler-Hammer and Elliott Engineers for the Irvin Works, Carnegie-Illinois Steel Corporation

ADC—Acceleration and deceleration computer.

WTR—WR^2 compensation, IR drop and stall tension regulator.

CTR—Strip speed, friction and windage compensation and tension regulator.

Features of the New Temper Pass Mill Drive

All operations are performed from an operator's cabinet at each end of the mill. Threading the strip through the single stand mill is accomplished in minimum time. Strip tension between mill and reels is then regulated to any desired value by means of the VSA current regulating exciters of each reel. By proper adjustment of the compensation for IR drop, friction, windage, and strip speed, the tension may either be held constant or tapered as required to provide a uniform quality of the processed strip. Any change in reel motor current and thus the tension, is translated to the VSA regulators which immediately modify the reel motor fields in such a way as to re-establish the tension. Sudden transient requirements of a wider current modification are also translated to the VSA voltage regulators of the reel generators which immediately respond to assist in establishing the desired current. The required change in current and torque when accelerating and decelerating is measured by a WR^2 compensating device which responds to actual rate of change in speed of the mill and thus insures the proper compensation with any rate of acceleration.

Cooperative efforts between the engineers of the Elliott Company and Cutler-Hammer have resulted in an outstanding development . . . the high-speed, single stand temper pass mill drive. The speed of the mill has been stepped up from 500 feet per minute to 2500 feet per minute with provisions for 3750 feet per minute in the future. Other operating features of this drive are described in the box at the left. In the greater production of high quality steel from this mill, you will find a hint why you should consult Cutler-Hammer Mill Control Engineering experience. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 27, No. 4.

TECHNOLOGY DEPT.

flat-rolled finishing equipment

PUBLIC LIBRARY
MAY 22 19
DETROIT

SHEARING LINES
SIDE TRIMMING, SLITTING AND RECOILING LINES
LEVELING AND OILING LINES
CONTINUOUS GALVANIZING LINES
CONTINUOUS TERNE LINES
CONTINUOUS TIN LINES

Flat-Rolled Finishing has come a long way in the last 25 years. During this time, Aetna-Standard has worked closely with the industry's specialists in pioneering many new ideas, such as: continuous galvanizing, continuous terne lines, high speed shearing and classifying lines and backed-up Roller Levelers.

Through its many achievements and work with the industry, Aetna-Standard is regarded as the leader in the designing, engineering and building of Flat-Rolled Finishing Equipment.

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:
AETNA-STANDARD ENGINEERING CO., LTD. TORONTO, ONTARIO, CANADA
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
SOCIETE DE CONSTRUCTIONS DE MONTBARD, 6 RUE DARU, PARIS (8e) FRANCE

Products of . . .

RIGID CONTROL

Roll control at National is constant. That is a principal reason why you can depend on National to make rolls to fit *your* individual requirements for precision and performance.

Control begins in the laboratory where raw materials are analyzed to meet our high metallurgical standards. Here, too, composition, heat treatment, hardness, chill depth and other characteristics are analyzed, charted and indexed for each roll.

In the foundry and roll shop, each step in manufacture is watched to assure you sound castings and precision machining.

These rigid quality controls plus National's years of metallurgical experience add up to superior National Rolls that more than meet your expectations.

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS AND CASTINGS

ADDED LIFE for Roll Stand GEARS

Photo courtesy Farrel-Birmingham Co., Inc.

Lower maintenance costs, too, when you use TEXACO MEROPA LUBRICANTS

Enclosed heavy-duty reduction gears and their bearings need extra protection in service. Use *Texaco Meropa Lubricants*. They are especially designed to cling to the gear teeth and cushion the load. Thus they assure smoother operation, reduce wear, prolong gear life, and minimize maintenance costs.

Texaco Meropa Lubricants have an exceptionally long service life and outstanding resistance to oxidation and thickening. They do not foam; do not separate in service, storage or centrifuging; guard bearings against corrosion.

To protect your oil film roll necks, use *Texaco Regal Oils*. They are heavy-duty turbine-grade oils with high resistance to oxidation, emulsification and sludging. You can count on them to keep circulating systems clean.

Let a Texaco Lubrication Engineer help you use effective lubrication to gain added efficiency and economy throughout your plant. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

TEXACO

TEXACO Meropa Lubricants
FOR STEEL MILL GEAR DRIVES

TUNE IN . . . TEXACO STAR THEATER presents MILTON BERLE on television every Tuesday night. Consult your local newspaper for time and station.

ALL 9 SALEM SOAKING PIT BENEFITS

1 CONSTRUCTION STRENGTH Circular shape, strong steel shell eliminates heavy buckstays . . . and dome cover with trouble-free seal provides durability.

2 UNIFORM HEATING Circular shape permits hot gases to diffuse equally in all directions — no pockets . . . no forgotten corners.

3 OPERATING ECONOMY Combustion control, burner location, bottom flue permitting only coolest gases to escape, keep cover and other maintenance costs at minimum.

4 EASY CHARGING AND INGOT POSITION Circular shape makes all space available — no corners to work out of. Perfected crane cover control enables speedy charging and discharging.

5 EFFECTIVE CONTROLS Pit design permits maximum performance efficiency from temperature, combustion, and pressure controls.

6 ADAPTABLE TO VARIOUS SIZE AND SHAPE OF INGOTS Ingots occupy the continuous periphery of the pit — waste space is held to a minimum.

7 SUITABLE TO PLANT AREAS Walkways and access spaces usually reduce encroachment on working areas. Minimum excavation and foundation work required.

8 MAINTENANCE AND OPERATION CONVENIENCE No straight line clearances are required. Flues, ducts, and cinder-buggy tunnels are conveniently located and are accessible under the pit bottom.

9 HIGH QUALITY PRODUCTION You get higher yield. Ingots are thoroughly heated for best rolling condition. Investigate the revolutionary practice of dry bottom operation.

Salem builds

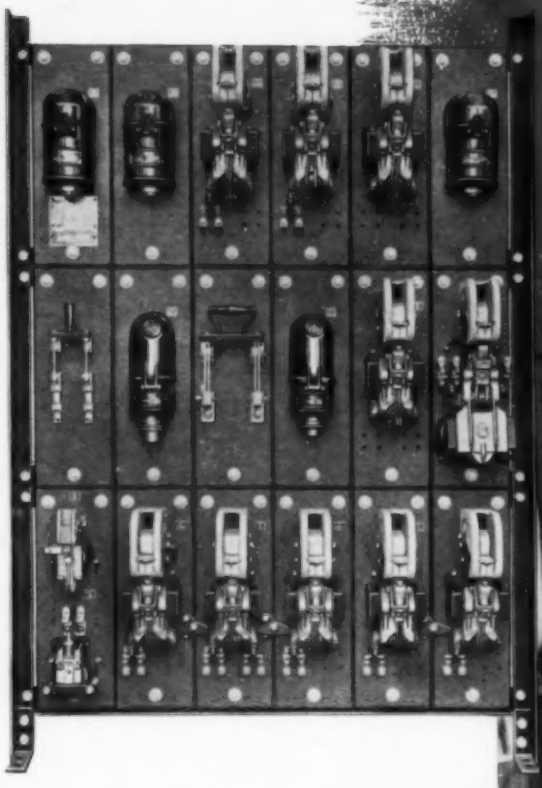
- CIRCULAR SOAKING PITS
- ROTARY HEARTH FURNACES
- CAR BOTTOM FURNACES
- FORGE FURNACES
- HEAT TREATING FURNACES
- GAS ATMOSPHERE FURNACES
- AIR RECIRCULATING FURNACES
- NEEDLE METALLIC RECUPERATORS
- CONTINUOUS BUTT-WELD FURNACES
- MECHANICAL EQUIPMENT FOR CHARGING AND DISCHARGING MATERIAL FROM FURNACES

SALEM

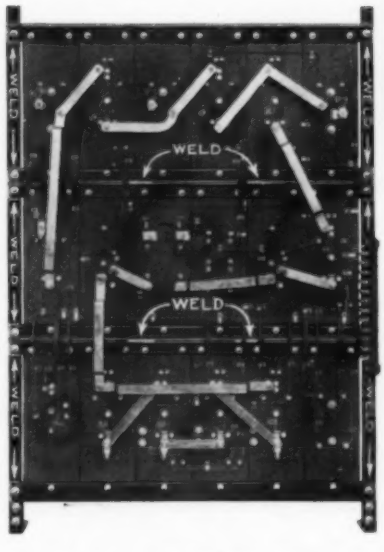
SALEM ENGINEERING CO. · SALEM, OHIO
TORONTO, ONTARIO, CANADA LONDON, ENGLAND

Quick Contact Renewing with...

EC&M LINE-ARC CONTACTORS



FRONT AND REAR CONTACTS REPLACED IN LESS THAN 2 MINUTES



Rear view of crane controller.

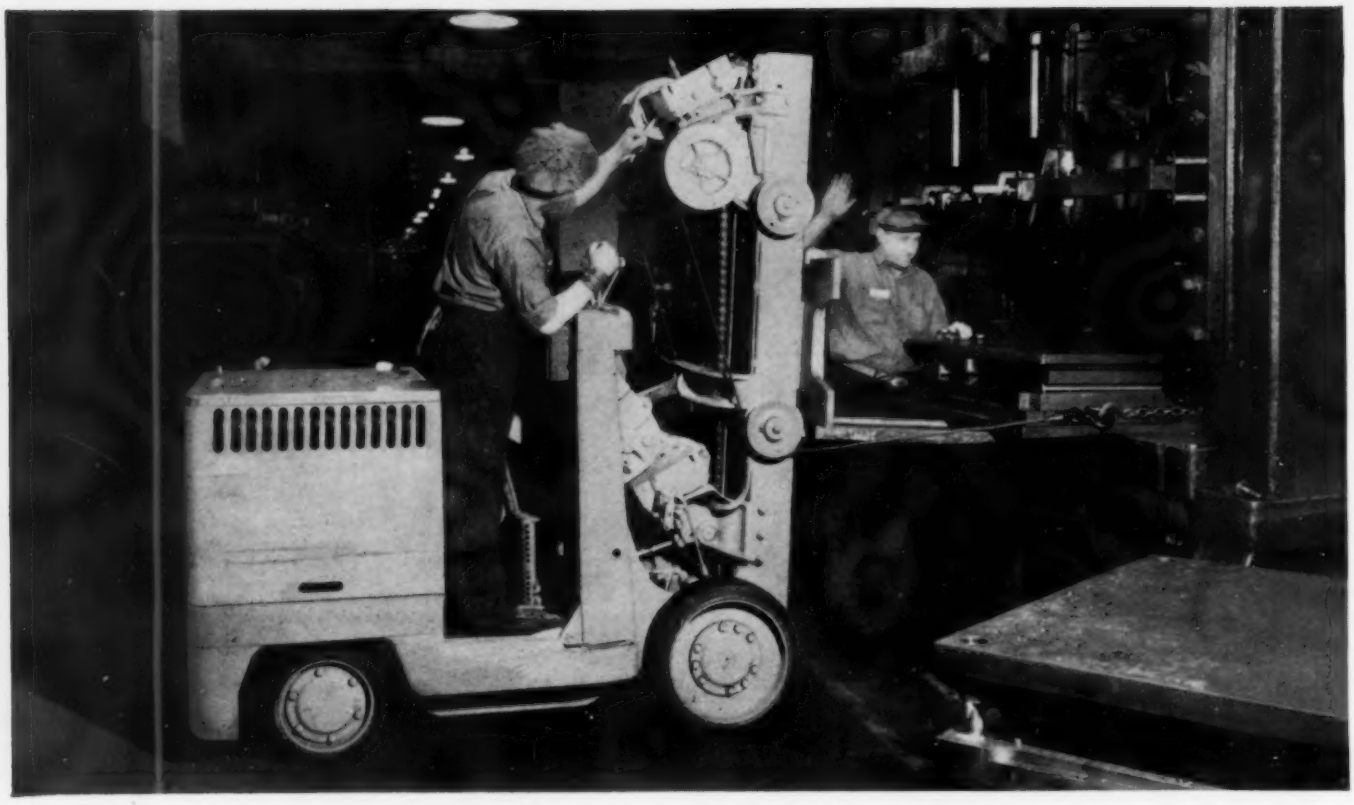
The EC&M LINE-ARC* principle assures long life of contacts, but, when needed, quick contact renewal is easily accomplished. Tests show the time for replacing stationary and movable contacts of EC&M *LINE-ARC* Contactors averages less than 2 minutes. Note that the use of a standard wrench permits good leverage for both loosening and tightening operations. There are no other contactor parts which must first be removed to make the contact tips accessible. All this encourages good maintenance.

Cost Cutting Features of EC&M Magnetic Control

1. Welded and bolted frame construction.
2. Individual Monson slate bases.
3. Double-break, isolated (safe) electrical interlocks.
4. Ease of contact renewal.
5. Elimination of the magnetic dust problem.

*The LINE-ARC principle keeps contacts cool. Cool contacts result from quick transfer of the arc to the arcing plate and circular guard over the blowout coil. The LINE-ARC principle causes the arc to leave the contacts quickly—oscillograms show that the arc is transferred in 1/500th of a second.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 East 79th Street Cleveland 4, Ohio

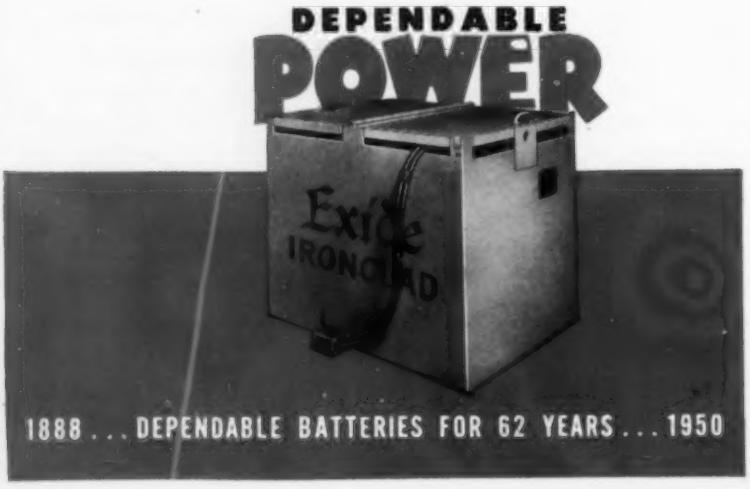


You get Split-second Handling with

Exide-Ironclad battery-POWER

Dependable Exide-Ironclad Battery power is your assurance of finger-tip control, accurate spotting, and steady operation of electric materials-handling trucks. Whether the load is light or heavy, Exide-Ironclads will deliver power instantly to meet all demands typical of *start-stop*, *lift* and *shift* manipulations of materials-handling trucks.

Exide-Ironclad Batteries assure full-shift trucking operations (around the clock or calendar) with no unscheduled periods of down-time to interrupt the flow of materials through your factory or warehousing operations.



The Exide-Ironclad Battery is *DIFFERENT* from all other batteries . . . different in design, construction and performance. The main difference is the Exide-Ironclad positive plate, which accounts for the superior operating characteristics and the exceptional long-life of Exide-Ironclad Batteries in more than a hundred thousand rough, heavy-duty jobs since 1910.

The operating cost of an Exide-Ironclad is low . . . a battery of average size costing less than a nickel per hour to recharge. Maintenance costs seldom exceed fifteen cents per shift. These important factors, together with the exceptional long life of Exide-Ironclad Batteries, provide the lowest cost source of *dependable, full shift* power that can be bought *at any price.*

Write for more facts and FREE copy of Exide-Ironclad Topics. It contains latest developments in materials handling . . . shows actual case histories.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

"Exide-Ironclad" *Reg. Trade-mark U. S. Pat. Off.*

BONNOT INSPECTION TABLE

PROVEN KEY TO Greater Steel Production AT LOWER COST PER TON

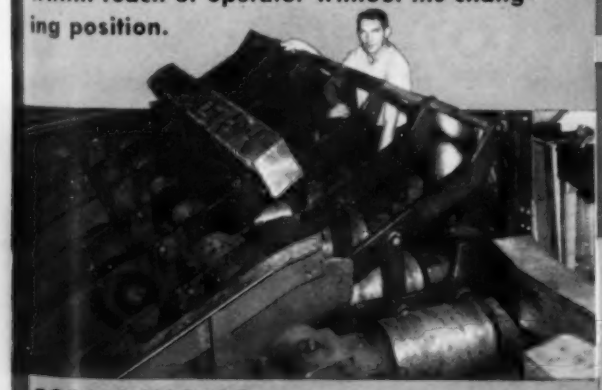
Whether you have *billets or bars—rods or rails—small slabs or tubes* for i spection in your mill, a Bonnot Inspection Tab will give you greater production . . . at lower cost per to

Used for any general inspection, or in conjunction with the Bonn Billeteer, the Hydraulic Inspection Table is another pioneerin development (proven in service) of Bonnot engineers that offe these major advantages:

1. assures faster, better inspection because inspector sees 2 faces at one time; he completes all operations from just one position, and with easy wrist motion.
2. enables inspector to work without interfering with Billeteer operator or other billet-cleaning workers and vice versa.
3. increases production because one Inspection Table can keep as many as 6 Billeteers operating at capacity.
4. segregates sizes of raw material so it can be "worked" in practical sequence; production up 15% or more.
5. available for other inspection work involving the quick, accurate and effective handling of heavy material.
6. saves machine time becau inspection and marking are do in advance.
7. eliminates need of putting material through machine; n mal practice when pre-machi inspection is not provided.
8. eliminates dangerous, time-co suming hard work of fla inspection.
9. reduces accident hazards, fre storage space for other us because material is handl more efficiently.
10. speeds "conditioning" by "so ing" material according to wo —(a) surfaced completely, (flaws or spotting, (c) reject (d) no machining.

EASY! Inspection and marking flaws in billet—one side; with Bonnot Hydraulic Inspection Table, operator works easily, efficiently, safely.

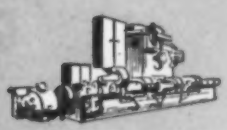
FAST! Inspection and marking flaws—2 sides and corner at the same time, and within reach of operator without his changing position.



ECONOMICAL! Discharging billet forward after marking. Note unmarked billet (at lower right) awaiting placement for "practically continuous" inspection.

BONNOT WILL "ENGINEER" AN INSPECTION TABLE TO YOUR EXACT NEEDS. WRITE TOD

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETE

ALSO MANUFACTURERS OF

for years ... the choice

NEWS ITEM

Large Order Placed For Annealing Furnaces

A contract for what is probably the largest single such commitment for coil annealing furnaces was recently placed by a large steel company.

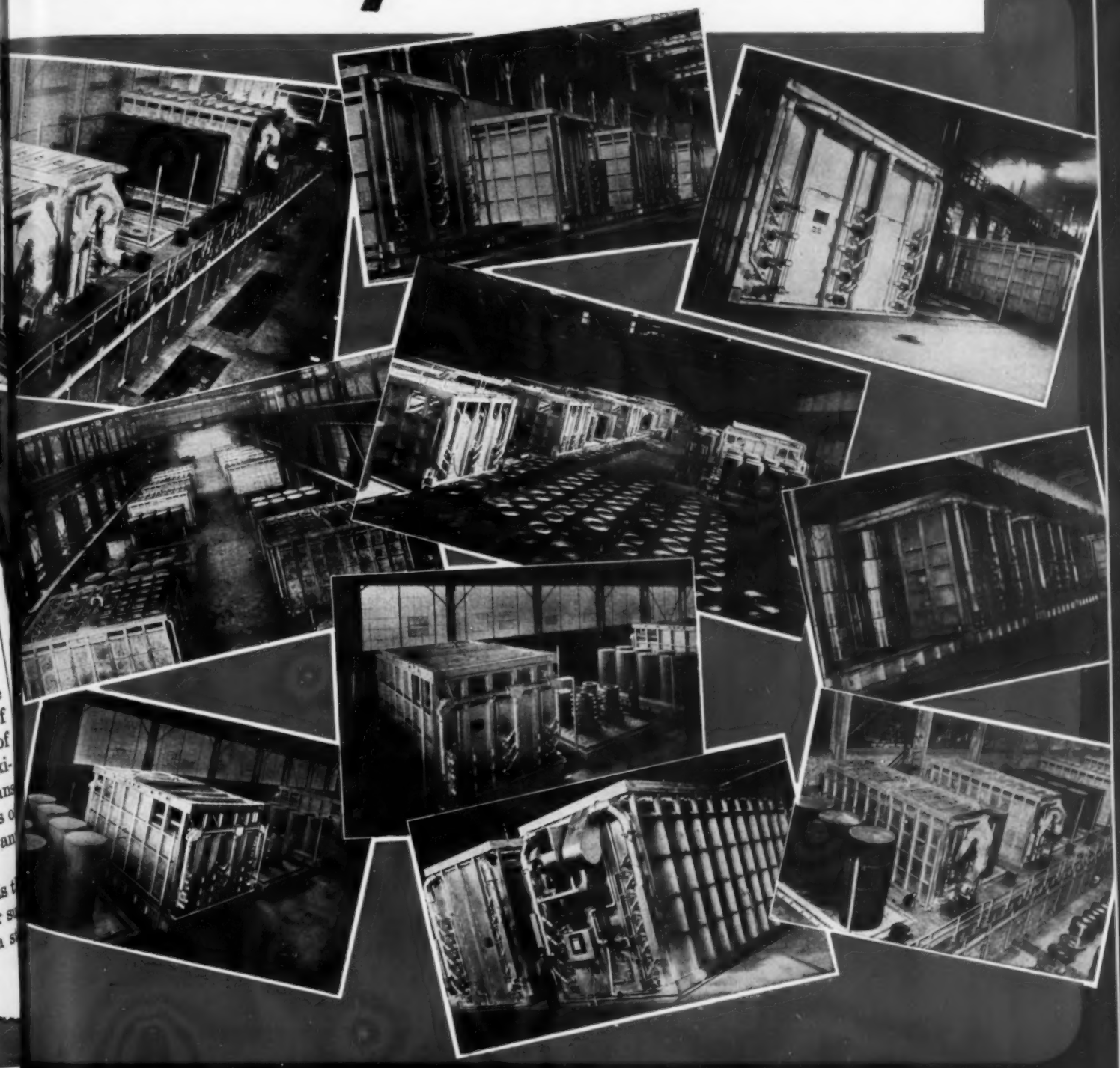
Twenty furnaces and sixty bases are to be built by Surface Combustion Corporation, Toledo, Ohio, under the terms of this contract. The furnaces will be of the horizontal radiant tube type and will be arranged with the sixty bases in a double row, each base accommodating eight stands of coils.

The annealing covers will accommodate coils 67 inches in outside diameter which may be piled to a maximum height of 148 inches. Total charge of coiled steel per base is approximately 450 tons. This means that as much as 27,000 tons of steel may be in process at any one time.

It is believed that this is the largest single contract for such equipment ever let by a steel company.

'Surface' SERVES THE STEEL INDUSTRY

...of leading steel mills ★



SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

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STEIN & ATKINSON, LTD.—LONDON
STEIN & ROUBAIX—PARIS, LEIGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

One-Way Fired Soaking Pits

Billet Reheating Furnaces

Slab Heating Furnaces

Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces

Controlled Atmosphere Annealing Covers for Wire and Rod

Controlled Atmosphere Annealing Covers for Coil and Sheets

Continuous Furnaces for Heat Treatment of Steel Plate

Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock

Continuous Type Bright Annealing and Normalizing Furnaces

Prepared Gas Atmosphere Generating Equipment

Pit Type Convection Furnaces for Rod Annealing

Stress Relief Furnaces

Wire Patenting Furnaces

Alliance CRANES GIVE YOU

DEPENDABILITY... day after day
OPERATING ECONOMY... year after year

● Keep industry on the move! That's Alliance's aim ... and we do just that, too, dependably, economically. Many industries daily report an uninterrupted flow of production. Their cost accounting departments year after year show reliable, ever-efficient lifting power that never tolerates down time. Why is this? Because Alliance cranes are built by experts, designers and engineers who have accumulated materials-handling experience of 50-odd years. . . . So keep 'em on the move with Alliance's dependable lifting power. Let Alliance, *the world's largest builder of the world's largest cranes,* develop time-saving, money-saving equipment perfectly suited to your company's operations. For best service and equipment you can rely on Alliance.

THE ALLIANCE MACHINE COMPANY

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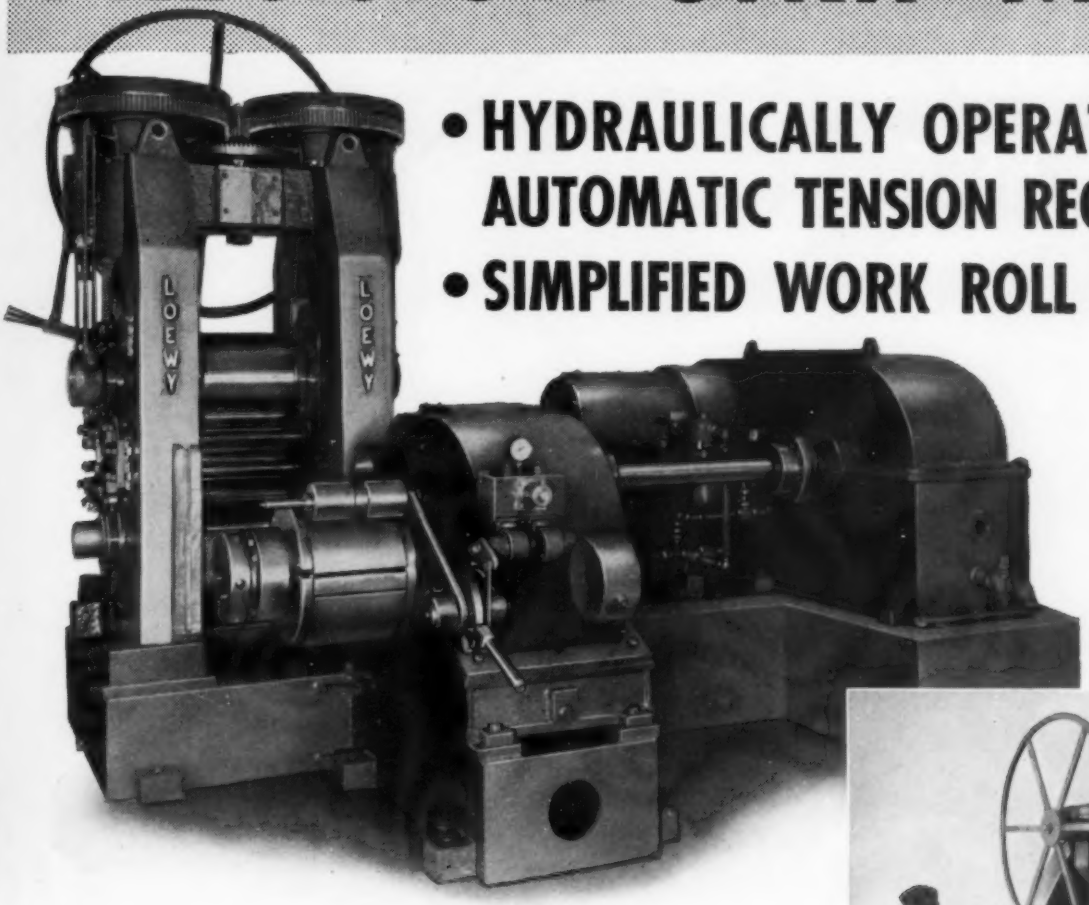
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET
OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

MODERN 4-HIGH PRECISION STRIP MILLS



- HYDRAULICALLY OPERATED AUTOMATIC TENSION REGULATOR
- SIMPLIFIED WORK ROLL CHANGE

CUSTOM BUILT TO YOUR SPECIFIC REQUIREMENTS

WRITE FOR FULL INFORMATION

HYDROPRESS · INC ·

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES • ACCUMULATORS • PUMPS

ROLLING MILLS

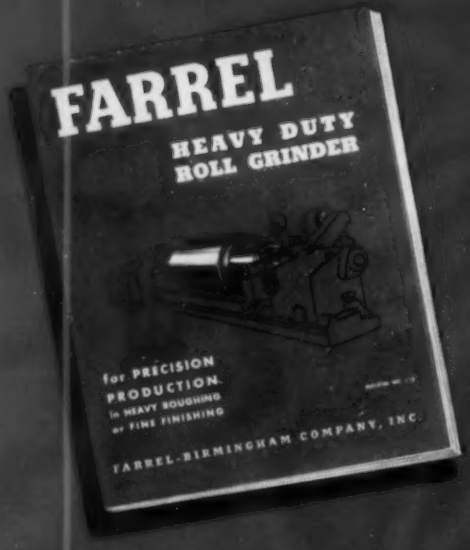
DIE CASTING MACHINES

566-568 LEXINGTON AVENUE AT 51st STREET NEW YORK 22 • N. Y.

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

WHEN YOUR ROLL IS HERE

it is ground



Write for Bulletin No. 115 which describes in detail the many features of the Farrel Heavy Duty Roll Grinder. A copy of this 28-page bulletin will be sent to you without cost or obligation.

quickly

Reports from users of Farrel® Heavy Duty Roll Grinders indicate that with the latest type of machines they are able to cut roll grinding time substantially. This is so for both heavy roughing and fine finishing.

flawlessly

Rolls are obtained with a perfect surface free from marks of any kind, either straight or with concave or convex contours ground to exact symmetry and accuracy.

economically

Faster grinding means increased productive capacity of the machine and less labor per roll ground. In addition, the rolls have longer life because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This is a vital factor in reducing the frequency of roll replacement and, consequently, the cost of new rolls.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

Loading up...FOR A 40% SAVING

CUT UP TO $200,000 A YEAR FROM REFUSE DISPOSAL COSTS

From Open Hearth to Dump and back again. That can be a costly operation or just a normal operating expense.

It all depends on the equipment used.

Gondola, hopper or obsolete air dump cars run the cost of refuse disposal way up out of sight. They're not built for the job. The heat of lading and banging of buckets makes maintenance and repair quite a sizeable item on your annual budget. On top of that, there's added labor costs, loss of operating time and haulage waste due to inefficient equipment.

Here's how you can bring those costs down within reach and maintain an even higher degree of operating efficiency – New Magor Air Dump Cars – built specifically for steel plant service.

New Magor Air Dump Cars are a modern low-cost approach to refuse disposal. They can take the roughest treatment year in and year out with a minimum of maintenance expense. Through labor and maintenance savings alone, you can write off your entire investment within a few years.

COST LESS THAN $1.35 A DAY

That's all it costs to own a 30 yd. 70 ton Heavy Duty Steel Plant Magor Air Dump Car – *dump cars that can cut your refuse disposal costs as much as 40%.*

The New **MAGOR** *Steel Plant Air Dump Car*

Write today for your copy of the new brochure, "The Answer to High Refuse Disposal Costs." This well-illustrated brochure explains, in detail, the many money-saving advantages of owning Magor Air Dump Cars.

MAGOR CAR CORPORATION · 50 CHURCH ST., NEW YORK 7, N. Y.

On every steel mill piping job
It's CRANE for complete selection

ECONOMICAL VALVES FOR LOW PRESSURES

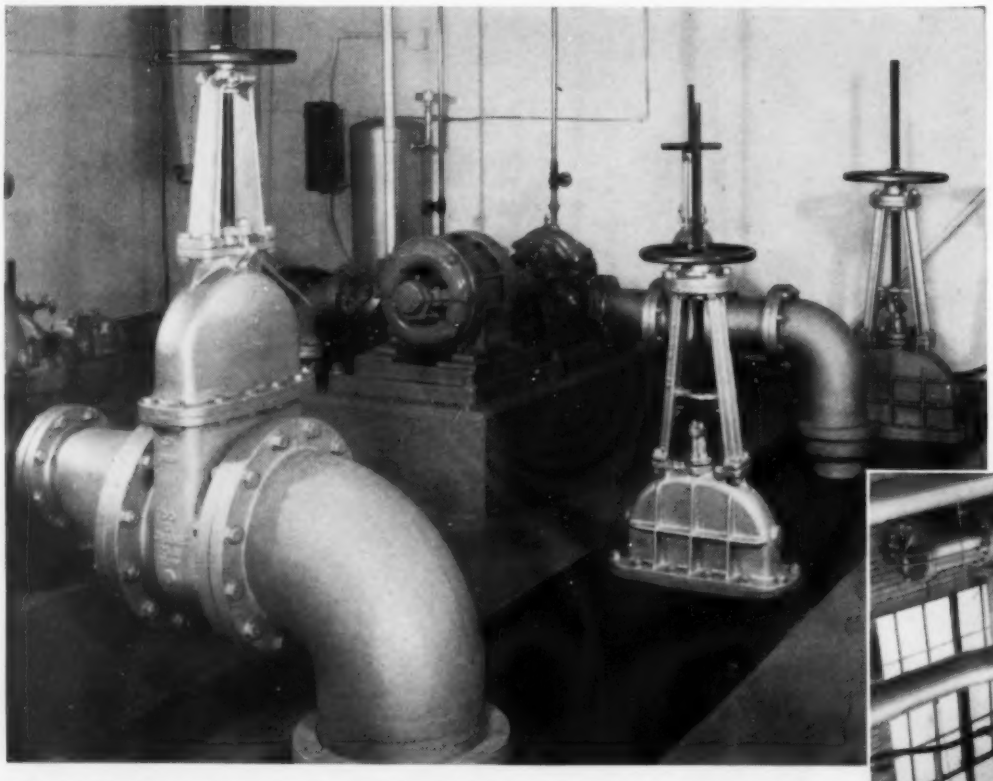
Keep Crane 25-Pound Iron Body Double Disc Gates in mind for services that don't require the usual 125-Pound valves. Rated at 25 Pounds Steam or Gas, and up to 50 Pounds Water, depending on size, they give superior service in a wide variety of applications. Use them inside or out; their oval-shaped body and bonnet have ample reserve strength under line stresses. Short and compact, they take minimum space in pipe lines.

For durable, tight seating—yet easy opening—seat rings and disc faces are brass. Crane 2-piece ball-type gland maintains uniform pressure on packing; prevents binding on stem; lengthens packing life. When specified, these valves are fitted with gears, by-pass, and clean-outs; also can be motor or cylinder operated. With non-rising stem, flanged or hub ends, up to 36 in.; OS&Y type with flanged ends only up to 48 in. See No. 49 Crane Catalog, p. 90.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

No. 793½, Outside Screw and Yoke. Working Pressures: 25 pounds steam or gas; up to 50 pounds cold water. Sizes: 10 to 48 inch.

ONE ORDER TO CRANE COVERS ALL YOUR PIPING NEEDS . . . VALVES, FITTINGS, PIPE, ACCESSORIES



RAW WATER INLET *lines to high service pumps, featuring Crane iron body double disc gate valves.*

AMMONIA LIQUOR SUPPLY LINES *to stills using Crane piping materials throughout. Valves are 20-in. low pressure all-iron double disc gates.*

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

BUILT FOR

Quick, Accurate, Economical

BATH TEMPERATURE MEASUREMENT

THE *ElectroniK* RECORDER

Platinum Molten Steel Thermocouple

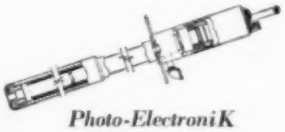


Photo-ElectroniK Bath Pyrometer

THE outstanding features of this *ElectroniK* Recorder are ideally suited to the specific requirements of bath temperature.

The features include: a large indicating scale and pointer, in addition to the recording pen and chart . . . pin-point accuracy that stems from standardization and circuit checking before each reading . . . and built-to-take-it construction that assures continuous, trouble-free service.

The flexibility of the *ElectroniK* Recorder permits the use of any type of sensing element. Systems incorporating either the Platinum Molten Steel Thermocouple* or the Photo-*ElectroniK* Bath Pyrometer** have acquired widespread acceptance throughout open hearth operations.

Call in your local Honeywell engineer for detailed specifications . . . he is as near as your phone!

MINNEAPOLIS-HONEYWELL REGULATOR CO.
INDUSTRIAL DIVISION
4464 Wayne Ave., Philadelphia 44, Pa.
Offices in 77 principal cities of the United States, Canada and throughout the world

COMMERCIAL · RESIDENTIAL · INDUSTRIAL
WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL

*Licensed by Republic Steel Corporation

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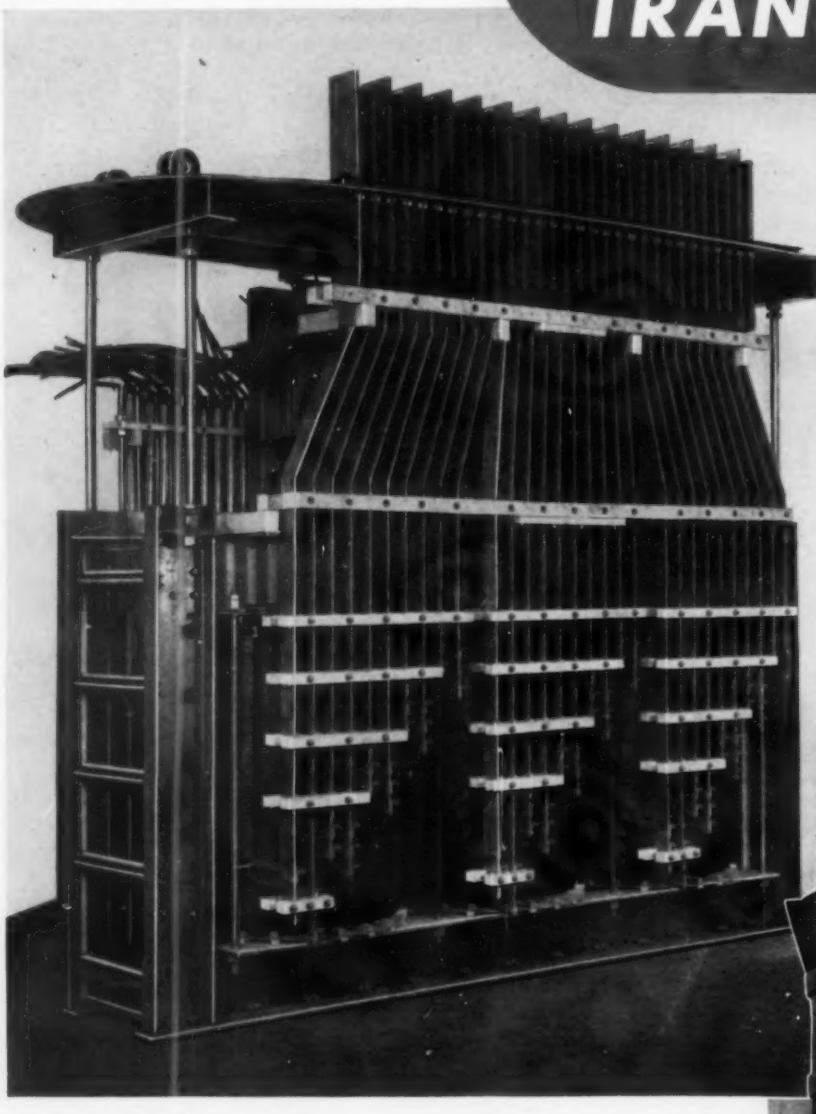
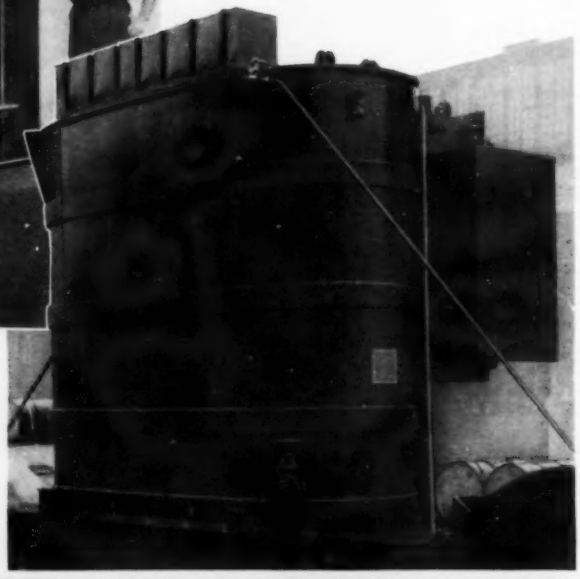
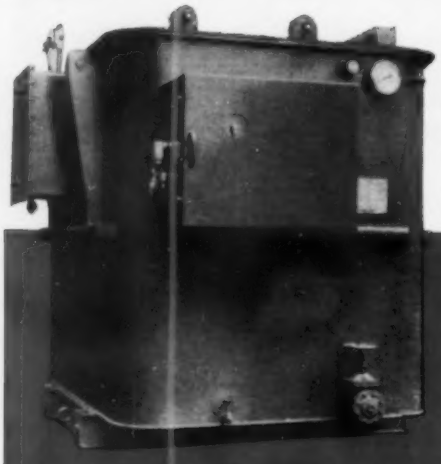
MINNEAPOLIS Honeywell — *Advanced Instrumentation* FOR METAL PRODUCING — BROWN INSTRUMENTS

Iron and Steel Engineers prefer PENNSYLVANIA FURNACE TRANSFORMERS



For over 30 years the designers of Pennsylvania Transformer Company have paced the industry in the development and construction of Electric Furnace Transformers. Many special conditions, not encountered in ordinary transformer design, such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses, have been met by continual research and sound engineering practice. The large number of Pennsylvania Furnace Transformers serving the steel industry today attest to their reliability and efficiency of performance.

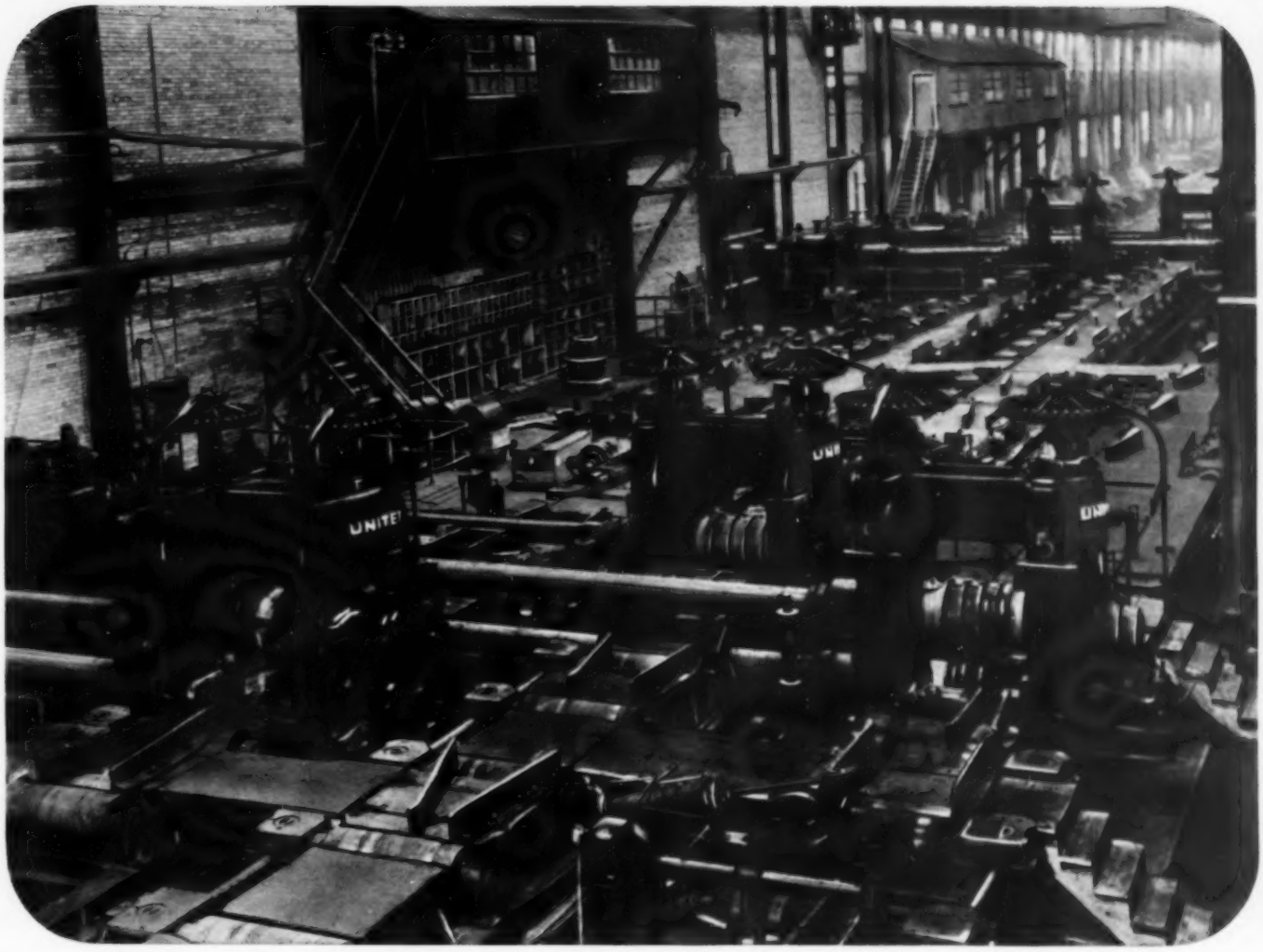




TOP 7500 Kva, 3 Phase, 25 Cycles, 40° C Rise, 12,000-240 volts, 33,300 Amperes.
RIGHT 7500 Kva Transformer mounted on flatcar for shipment.
LEFT 7500 Kva, 3 Phase, 60 cycles, OIWC, 13,200—255 volts

Pennsylvania TRANSFORMERS

Pennsylvania
TRANSFORMER COMPANY
CANONSBURG, PENNSYLVANIA



24" BILLET MILLS

Designed and built by **UNITED**

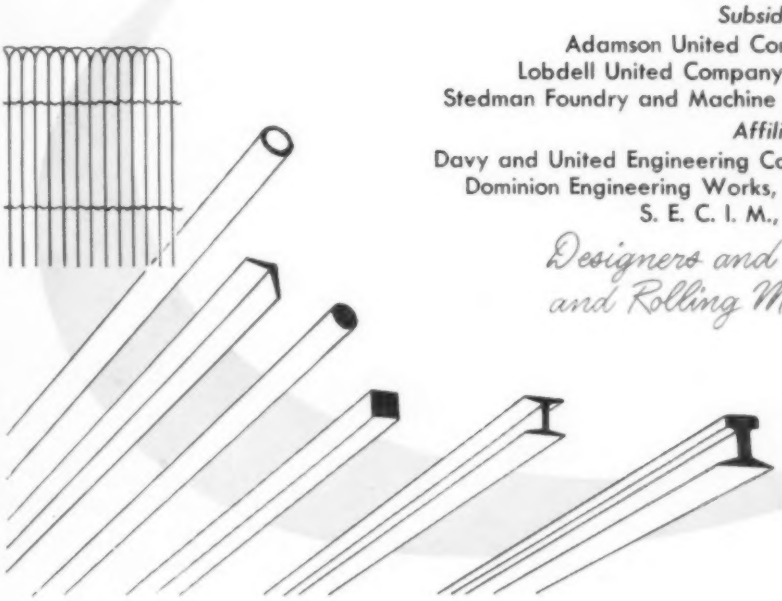
ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Subsidiaries:
Adamson United Company, Akron, Ohio.
Lobdell United Company, Wilmington, Delaware.
Stedman Foundry and Machine Company, Inc., Aurora, Indiana.

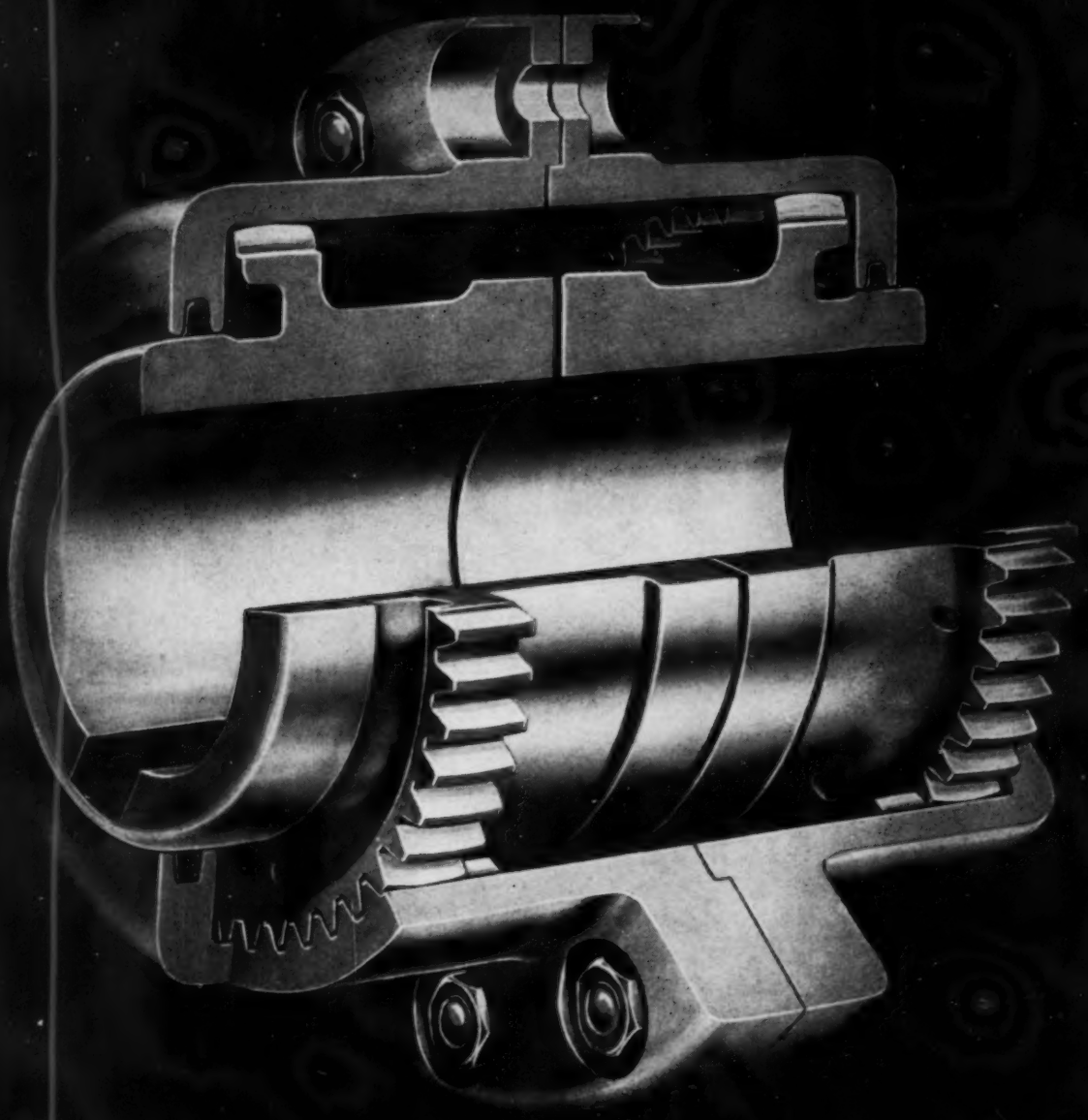
Affiliates:
Davy and United Engineering Company, Ltd., Sheffield, England;
Dominion Engineering Works, Ltd., Montreal P. Q. Canada;
S. E. C. I. M., Paris, France

Designers and Makers of Rolls and Rolling Mill Equipment



UE&FCO
REG. T. M.

POOLE



COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

OLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

(Partial view of the enormous new lubricating oil plant at Lake Charles, La., where this great new oil is processed.)

"ANTI-FOULING" OIL made by the Remarkable new "HEART-CUT" PROCESS

This new oil—the best known to science... gives you a cleaner engine... more economy ...minimum carbon residue.

It's here now! The remarkable motor oil from the giant new $42,000,000 lubricating oil plant at Lake Charles, La. The plant that's been the big talk of the oil industry for months.

New Premium Koolmotor is made by the unique "Heart-Cut" Process which retains only the choicest part of the finest crudes. *It's so superior that in recent engine tests it outscored nine other major premium motor oils.* No wonder Premium Koolmotor is better in every way! Cleans better, seals better, cools better and fights acid, sludge and corrosion far more effectively. Switch to this remarkable new oil today.

start saving Dollars today... stop at

CITIES SERVICE

TORRINGTON BEARINGS

help roll Crucible's quality stainless steel

Heavy-duty Torrington Bearings contribute to the steady production of highest quality stainless steel in the new Crucible Midland mill. Work rolls of the special 66" 4-high reversing hot mill, as well as the work rolls and back-up rolls of the new 3-stand tandem cold mill, operate smoothly on Torrington Four-Row Tapered Roller Bearings.

Higher load capacity is available in Torrington Roll Neck Bearings with minimum cross-section to permit maximum roll neck diameters for greater strength.

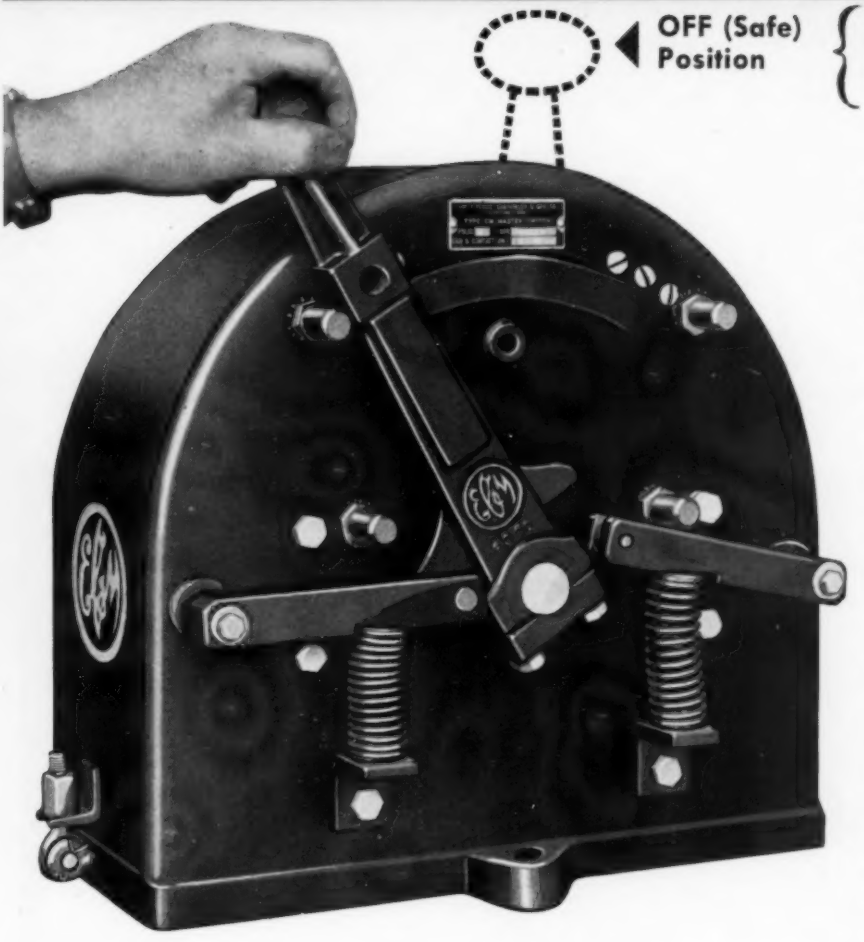
Torrington engineers are always ready to help solve your friction problems. Call on us for bearing design, application or maintenance recommendations.

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *TAPERED ROLLER* **BEARINGS**

SPHERICAL ROLLER · TAPERED ROLLER · STRAIGHT ROLLER · NEEDLE · BALL · NEEDLE ROLLERS

Master Switch *automatically* returns to Off-Position from any speed-point in either direction . . .



Provides Safe Operation should operator fall or otherwise remove his hand from master-handle.

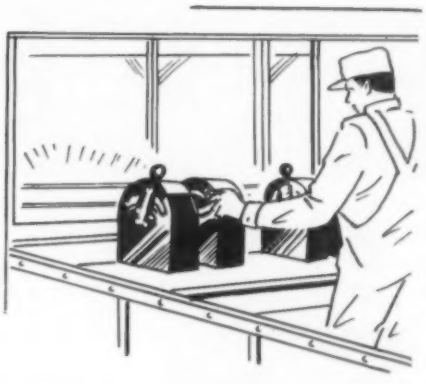
There are several *speed-control* applications where *safe* practice dictates that power be automatically disconnected from the motor-driven machine the instant the operator leaves his station or for some other reason removes his hand from the master switch. A typical example is a transfer (or larry) car with a *spring-return* master switch mounted on the side within reach of the operator as he walks along with the car. Should he trip and fall, the master switch automatically centers itself in the off (safe) position.

The EC&M Cam-type Master Switch (as illustrated) is ideal for this service because of the *short-throw* of the operating handle. From the "full-on" to the "off" position, the handle of an EC&M Master travels less than 40° from the sixth speed-point in either direction to the off (central) position. There's nothing to equal the EC&M Cam Master Switch for spring-return service.

Make your own Compact Layouts with EC&M Bulletin 1190 Cam MASTER SWITCHES

in Crane-cabs or Mill-pulpits

For new installations or when re-vamping existing equipment, take advantage of the narrow width and short-throw of EC&M Cam Master Switches for improved performance. These features appeal to operators.



Write for Bulletin 1190 giving details of these short-throw, narrow width Masters

THE ELECTRIC CONTROLLER & MFG. COMPANY

2698 E. 79th STREET — CLEVELAND 4, OHIO

For low-cost trips—take a drive on TIMKEN® bearings

THE machine below is a 10,000 lb. capacity auto floor manipulator. It's made by the Edgar E. Brosius Company. It takes steel bars from furnace to forging press and positions them during forging. Timken® bearings on the drive mechanism and wheels help to lower the cost of its trips—in two ways.

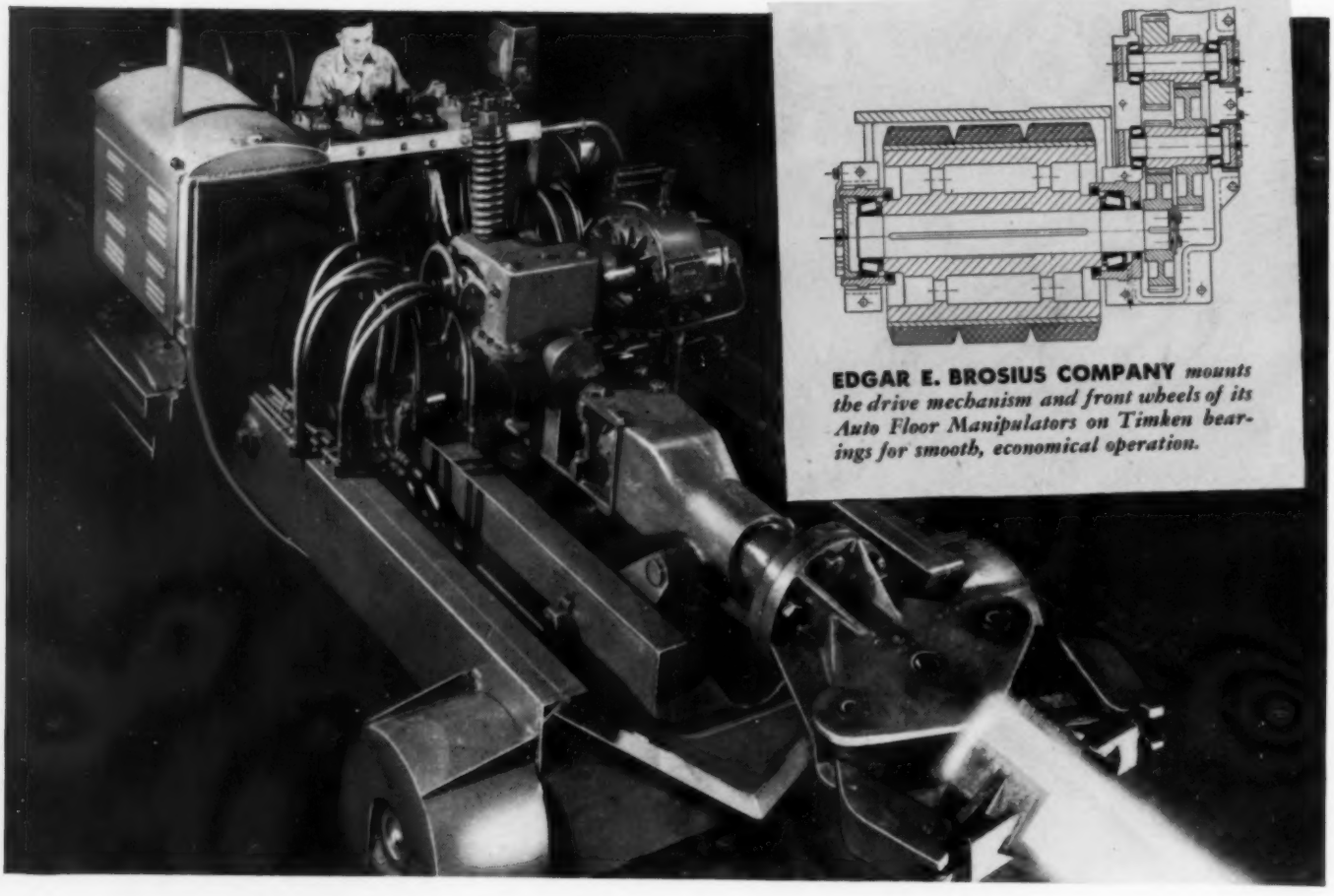
First, Timken tapered roller bearings keep the shafts in precise alignment, the gears in close mesh. Wear on parts is reduced. The machine lasts longer and replacements are fewer.

Second, bearing maintenance costs are reduced.

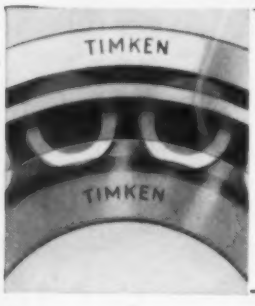
The tapered design of Timken bearings enables them to carry radial, thrust and combination loads. Line contact between rolls and races gives them the capacity for the toughest loads. Their true rolling motion and amazingly smooth surfaces virtually eliminate friction. And Timken bearings normally last the life of the machine because they are engineered for the job, made of Timken alloy steels, and precision manufactured.

No matter what kind of machines you make or use, always make sure the bearings are the best. Look for the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



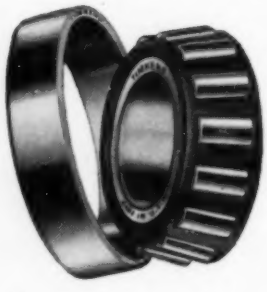
EDGAR E. BROSIUS COMPANY *mounts the drive mechanism and front wheels of its Auto Floor Manipulators on Timken bearings for smooth, economical operation.*



POSITIVE ROLLER ALIGNMENT
Wide area contact between roll ends and rib of the cone prevent Timken rollers from skewing. Result: bearings roll easier, last longer.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →○← LOADS OR ANY COMBINATION ✳

extra service for your equipment when "WEAR-RESISTED" with AIRCO hardfacing alloys

Because of the hardness and other desirable characteristics of these alloys, they provide high resistance to all types of wear—abrasion . . . impact . . . heat . . . corrosion. One application often adds 2 to 25 times longer service life to *worn or new* parts . . . big dividends in savings of "down-time" and replacements.

There is an Airco alloy available for oxyacetylene flame or electric arc application to meet all types of wear conditions.

1. ***Severe abrasion and medium impact***
2. ***Shattering impact and abrasion***
3. ***Severe impact and abrasion***
4. ***Sliding abrasion and impact***
5. ***Extreme earth abrasion***
6. ***Corrosion and heat***

Constant research is developing new alloys to meet special wear problems as they occur.

If you have parts or tools subject to any type of wear, it will pay you to investigate the savings you can make in maintenance and replacement costs by using Airco Hardfacing Alloys.

For further information about Airco's complete line of "wear-resistant" alloys, write your nearest Airco office or Authorized Dealer for a free copy of the Hardfacing Alloys Catalog.

More news about AIRCO products

FOR SEVERE IMPACT
AND RESISTANCE TO ABRASION
Airco No. 388 Electrode

A shielded arc electrode sufficiently high in alloy content to produce a deposit bearing approximately 9% chrome and 0.9% carbon. This alloy content results in a weld metal deposit which is essentially martensitic.

Operators will find that the exceptionally fine arc action of Airco No. 388 increases both the speed and quality of their work.

FOR RESISTANCE TO
EXTREME EARTH ABRASION
Airco Tungtube
Nos. 8, 10, 20, 30 and 40

These are fabricated rods of tungsten carbide particles encased in a steel sheath. The various Tungtube numbers indicate the screen size of the tungsten carbide particles contained within the tube. With its extreme hardness tungsten carbide ranks second only to the diamond in earth cutting efficiency. It is accepted as the standard means of cutting non-metallic substances; such as, coal, shale, and granite. It is recommended for core bits, fishtail bits, road plows, coal cutter knives, plow shares and similar equipment subjected to extreme earth abrasion.

CORROSION—ACID RESISTANT
ALLOYS FOR WELDING HARDER
GRADES OF ALUMINUM BRONZE
Airco Nos. 100, 116, 120, 125
and 130 Electrodes

For joining aluminum bronze or other metals and combinations of dissimilar metals—and for overlays on bearing surfaces, machine parts, dies, etc. The deposits made with these electrodes are corrosion and acid-resistant and will also retard wear from abrasion and impact.

AIRCO **AIR REDUCTION**
Offices in Principal Cities

DOWN-TILTERS

discharge hot-strip coils from power chain conveyor at Gary Sheet & Tin Mill

These are two of the five Down-Tilters which are part of the hot-strip coil handling system at the Gary Sheet and Tin Mill, Carnegie-Illinois Steel Corp. The Down-Tilter in the foreground is shown removing a coil from the conveyor and down-tilting it to troughed gravity rolls for removal by crane or ram truck. The drive shown is a 100 h.p. herringbone gear reducer and enclosed roller chain drive to conveyor head shaft.

The entire conveyor system provides gentle, controlled transportation of hot coils without rolling or scuffing for maximum mill yield. Electrical units are synchronized to assure the desired continuity of mechanical handling from coilers to discharge points.

Link-Belt engineers are pleased to make their broad experience available to you on matters involving materials handling and mechanical power transmission.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Cleveland 15, Pittsburgh 13, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 11,631

Whitcomb 25-ton Diesel electric locomotive, narrow gauge, in operation at the Ohio Works (Youngstown) of the Carnegie-Illinois Steel Corporation. One of four Whitcomb Industrial Diesels operating here.

A compact, powerful Whitcomb 50-ton Diesel locomotive delivers inbound cars of scrap and material to the 100-acre plant of Scullin Steel Company, St Louis, Missouri.

Whitcomb 70-ton Diesel electric pushing two submarine type cars of molten metal to an open hearth in the Steelton, Pennsylvania, area. Steelton & Highspire Railroad Company.

Whitcomb Industrial Diesels: Cost-Saving Production Tools Used Throughout Industry

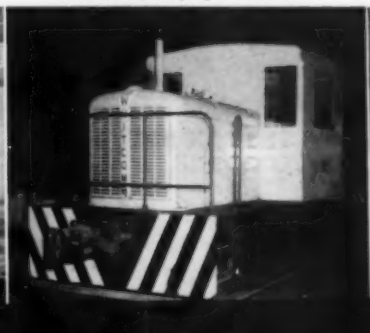
Wherever materials must be moved in volume, on schedule, and at minimum cost — you'll find Whitcomb Diesel locomotives turning in enviable performance records. Whitcomb Diesel locomotives provide the compact power, the speed, the high availability, the durability needed to meet exacting production schedules. That's why important companies choose Whitcomb Diesels for important jobs.

Whitcomb Industrial Diesels are available in weights from 3 to 95 tons, each tailored precisely to the work to be done. Today, take the first step toward lower production costs by writing for complete information on the Whitcomb Industrial Diesel locomotive line.

Fueling up a Whitcomb 80-ton Diesel electric at a large eastern steel plant. Fuel economy combines with high availability, complete dependability, to assure profitable performance.

In a typical application, where economy counts, a Whitcomb 8-ton Diesel mechanical locomotive delivers materials from plant to warehouse at Revere Copper & Brass Inc., Baltimore, Md.

Whitcomb 20-ton Diesel mechanical locomotive of a type widely used in steel-making operations.



There is no power cheaper than Diesel; no locomotive finer than a Whitcomb.

THE BALDWIN GROUP

THE WHITCOMB LOCOMOTIVE CO.

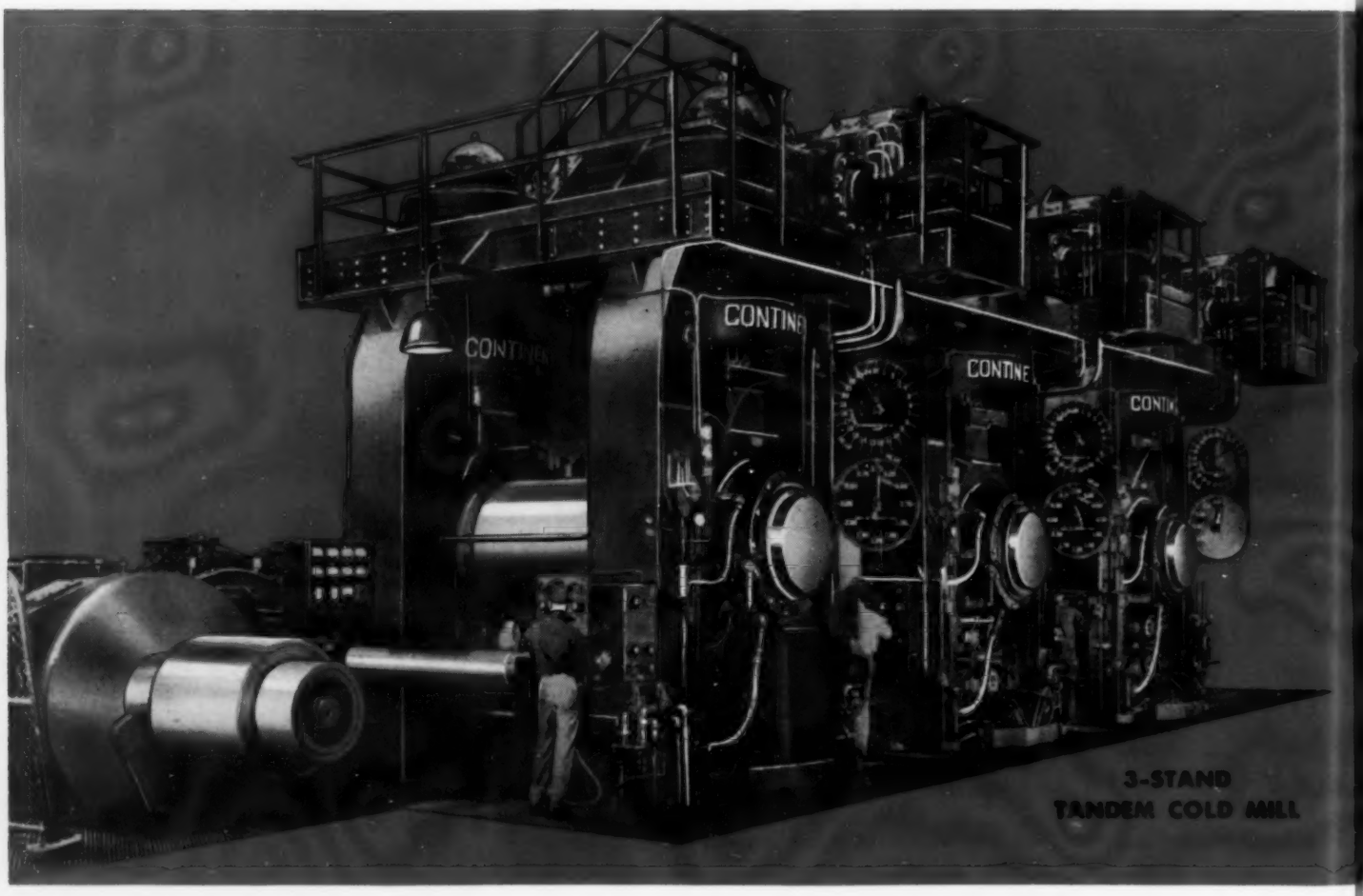
ROCHELLE, ILLINOIS

Subsidiary of

THE BALDWIN LOCOMOTIVE WORKS

Continental **ROLLING**

of all types, including auxiliary



PRODUCERS OF: Complete Rolling Mill Installations including:

Blooming Mills	Plate Mills	Non-Ferrous Mills	Tables
Structural Mills	Slabbing Mills	Roll Lathes	Transfers
Bar Mills	Universal Mills	Ingot Mold Cars	Shears and other auxiliary steel plant equipment
Billet Mills	Hot Strip Mills	Charging Box Cars	
Merchant Mills	Cold Strip Mills	De-Pilers	

IRON, ALLOY IRON and STEEL ROLLS for ferrous and non-ferrous rolling mills; pulp and paper industry; textile industry; and milling, cereal and vegetable oil industries.

* * *

CARBON and ALLOY STEEL CASTINGS from 20 to 250,000 pounds. Complete heat treating and machining facilities.

MILLS

equipment

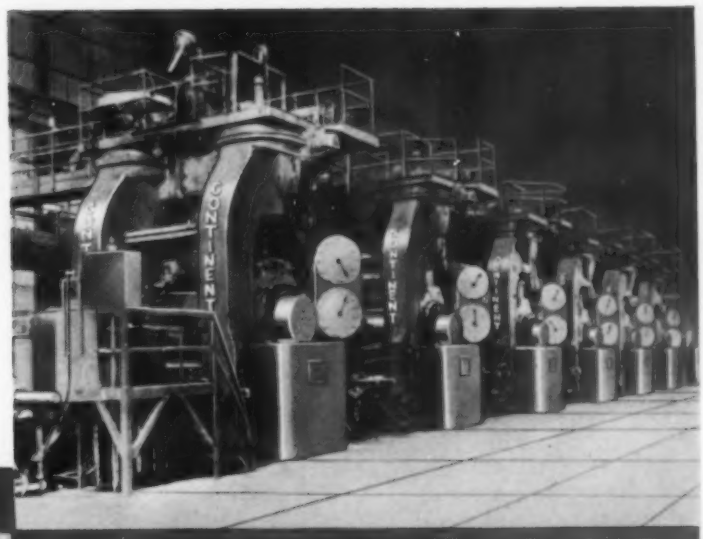


PLATE MILL LEVELER AND TABLES

Continental

FOUNDRY & MACHINE CO.

CHICAGO • PITTSBURGH

Plants at: East Chicago, Ind.; Wheeling, W. Va., Pittsburgh, Pa.

ROLLS—
STEEL CASTINGS

SLAB TURNING GANTRIES

When your Slab Turning Gantries are "Shaw-Box," you get all the advantages of outstanding engineering and construction excellence for which "Shaw-Box" Steel Mill Cranes are known throughout the industry — plus proven safeguards to prevent damage to the Gantry.

Slab Turning Gantries have long been a "Shaw-Box" specialty. They are built to perform under the most severe operating conditions with a minimum of maintenance attention and expense. They fully conform to AISE specifications. Outstanding mechanical advantages include a perfected rachet device that disengages the hoisting mechanism if load is carelessly handled, eliminating the possibility of raising the trolley off bridge when engaging loads. Ram may be removed without disturbing the operating mechanism. Roller guides prevent swing of mast and guide the rams.

"Shaw-Box" Slab Turning Gantries, today, offer the greatest value for every dollar invested.

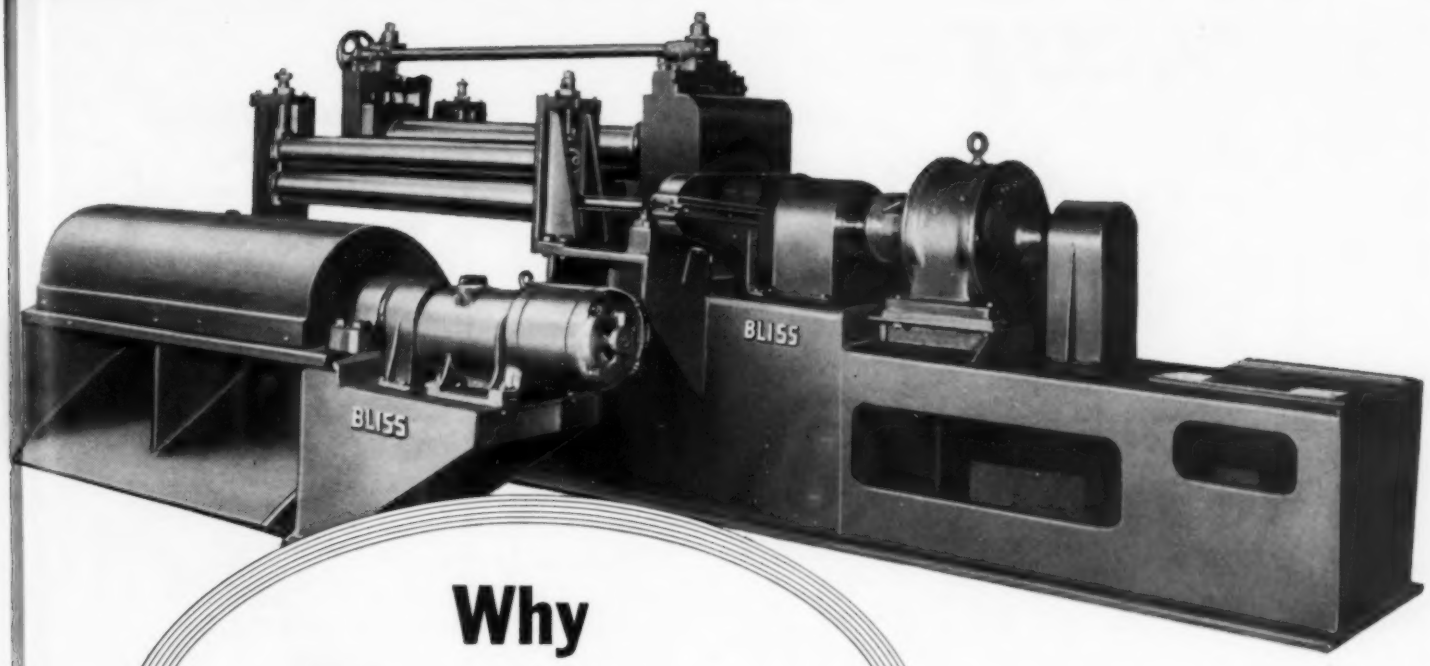
Be sure to send all your inquiries and specifications for Slab Turning Gantries and Steel Mill Cranes to "Shaw-Box."

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

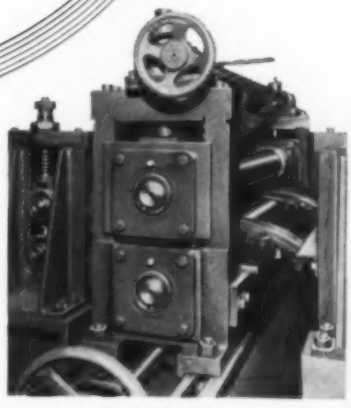
MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties. Makers of 'Asheroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.



One of many models of Bliss Slitters with scrap chopper which handle coil and sheet up to 48" wide and .135 gauge.

Why Bliss Slitters are cost-cutters, too!



End view of slitter arbor housing. Complete arbor can be removed and changeover made in 15 minutes.

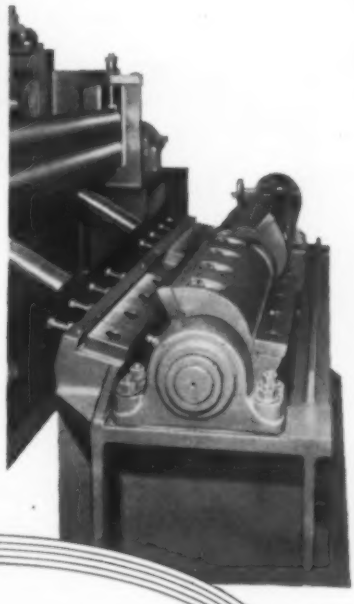
Add up these savings in both time and money with Bliss slitting equipment:

1. **Lower initial cost of stock.** You can buy sheets or coils in "least common denominator" widths—at considerable price savings.
2. **No production delays** waiting for unusual or hard-to-get stock widths.
3. **Eliminate stock waste.** If your specifications change, you'll have no useless inventory to dispose of. You cut metal to your needs—as you need it.
4. **Easy storage and handling.** No extra facilities needed to keep a variety of widths on hand.

Unusual service requirements are easily met by setting up Bliss Slitters either for a sheet or coil-operating line. Complete arbors with spacers and cutting knives can be removed easily for interchangeability, knife dressing, and alignment. Complete changeover takes *only* 15 minutes.

Bliss Slitters are rugged in design, accurate and reliable in operation and simple to maintain. They are adaptable to any type of continuous or semi-continuous operation on various metals in a wide range of widths and gauges. For added profits and ease in handling, a Bliss Scrap Chopper can be teamed up in a natural combination with the slitter.

Let Bliss help you "hold the line" on manufacturing costs. In slitters, as in rolling mills and power presses, it pays to put your problem up to Bliss.



Scrap chopper used with slitter to chop trimmed stock for easy and profitable handling.

E. W. Bliss Company

General Office: Toledo 7, Ohio

Rolling Mill Division

Salem, Ohio

Rolling Mills, Mechanical and Hydraulic Presses, Container Machinery

No Stuffing Box Troubles–

BECAUSE THERE ARE NO STUFFING BOXES,

in

HAGAN

RING BALANCE METERS

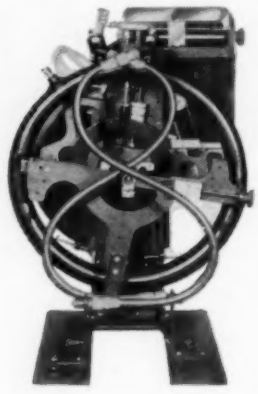
The design of Hagan Ring Balance Meters eliminates stuffing boxes—and hence eliminates the troubles that go with them. Adjustment is less delicate, less maintenance is required; there is one less source of friction, hence greater sensitivity; there is no danger of leakage, therefore no way in which the fluid being measured can come in contact with any critical mechanism. No leakage means also that the meter stays in calibration over a much longer period.

Absence of stuffing boxes is, however, only one of the many important features of Hagan Ring Balance Flow Meters. They are rugged, sensitive, versatile—suitable for virtually every flow-metering application, including many applications which are almost impossible with conventional meters. For full information, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

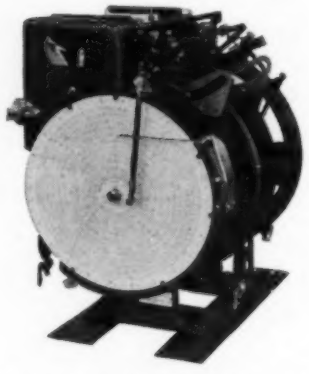
SOME TYPICAL

HAGAN

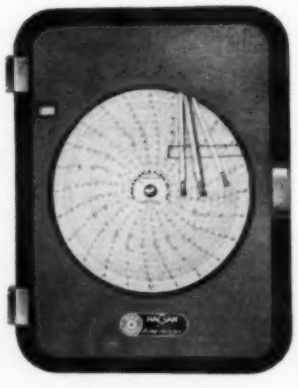
RING BALANCE METERS



Back view of single ring, high differential meter, showing S-tube connection.



Front view of dual meter with one high differential and one low differential ring.



Front view of three-pen meter in case. Panel space is the same for all models.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

HAGAN
HALL
BUROMIN
CALGON

THE MORGAN
AIR EJECTOR

Expels hot gases better . . .
and more economically

BETTER because it gives you a constant, positive exhaust, instantly adjustable to any draft or pull . . . the weather has no effect on the draft, temperature of the gases or action of the furnaces . . . the Morgan Air Ejector produces higher draft, gets the most from any combustion equipment.

MORE ECONOMICAL because it needs no cumbersome, expensive stack . . . needs no expensive foundations. Quickly installed, it eliminates the time lost waiting for extensive alterations . . . gets the furnace back in operation with little delay. *It is less expensive to use one Morgan Air Ejector on each furnace than several furnaces connected with one tall stack.*

You'll find it worth-while to get the complete story. Write us about your setup.

CCC-21

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

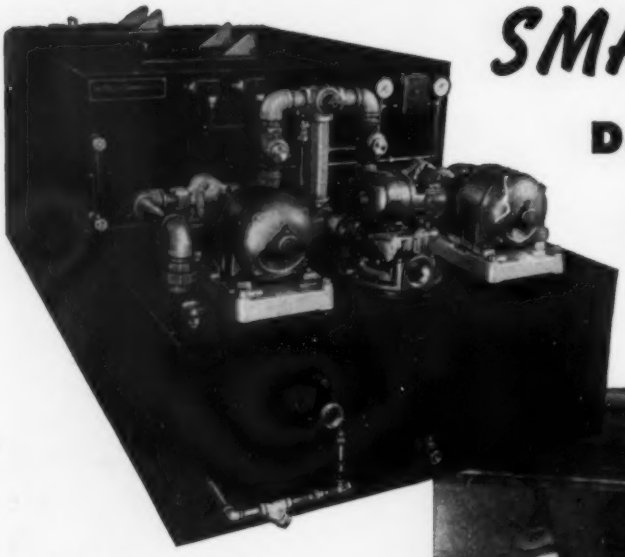
HOW IT OPERATES

Cool air is directed upward through the venturi throat, creating a powerful suction in the stack. Superheated gases, fumes, etc., are drawn out without passing through the fan. The gases are mixed with cool air and discharged at low temperature to the atmosphere.

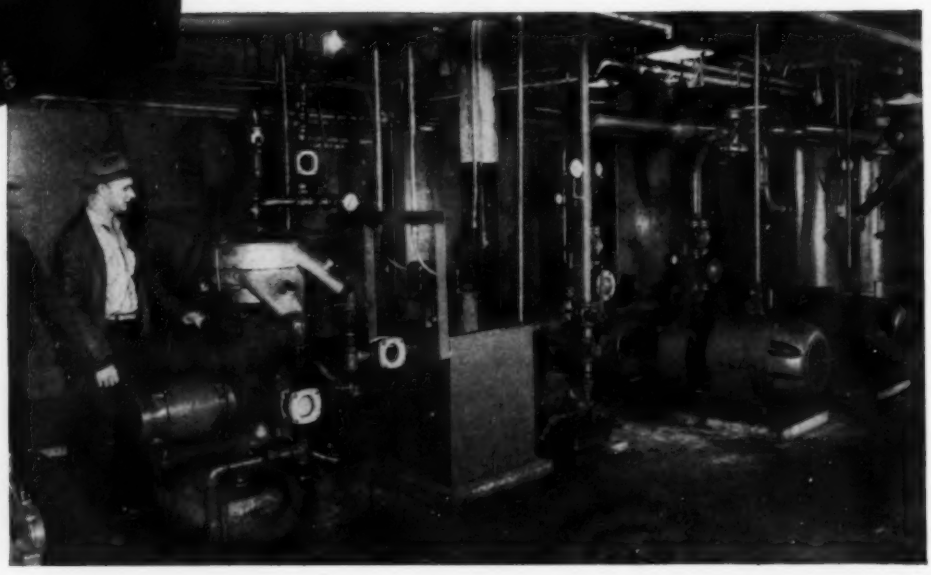
SMALL MILL OR LARGE---

De Laval Lubrication Systems

ARE ENGINEERED TO FIT!



De Laval "Unilube"— self-contained unit



Part of a De Laval Custom-designed Lubrication System

De Laval Mill Lubrication Systems are designed for all sizes of mills. For large mills, the lubrication systems are custom-designed. For smaller mills, De Laval offers the Unilube System which is a self-contained unit with circulating capacities of 1 to 40 g.p.m.

In both cases, the De Laval Lubrication Systems are completely engineered. They all include the proper selection of pipe size, the correct metering of the lubricant, the proper control of temperature, and purification of the lubricating oil.

Oil purification is accomplished by means of the De Laval centrifugal Oil Purifier, which continuously removes contamination and water. By keeping the lubricating oil clean and dry, bearing life is prolonged and maintenance costs are minimized.

Write for additional information.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, N. Y. 6 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
61 Beale St., San Francisco 5

DE LAVAL

ENGINEERED SYSTEMS

When detecting temperature by radiation method . . .

● ***Quick-sighting optical system*** **lets user select desired target easily, and then check the sharply-defined area which the Rayotube sees. Increased sharpness is also of benefit when radiation comes from end of a closed tube.**

● ***Hermetically sealed construction*** **at lens, window, and leadwires keeps out dust and gases. New design guards inherent accuracy and stability, even with high or rapidly changing Rayotube housing temperatures.**

Which do you want?

If you already know about Rayotubes, we'll send you brief material to bring you up-to-date on the new model. If you want the full story on all Rayotubes, ask for Cat. N-33B. Please specify. Write Leeds & Northrup Company, 4942 Stenton Ave., Phila. 44, Pa.

Built to work with all Micromax and Speedomax Rayotube instruments, this new Rayotube is an important advance in radiation pyrometry. Present users of Rayotubes, as well as future ones, will find this completely new, advanced design detector unusually easy to apply, especially to such equipment as slab furnaces, soaking pits, open-hearths, ceramic kilns . . . wherever operating conditions are severe.

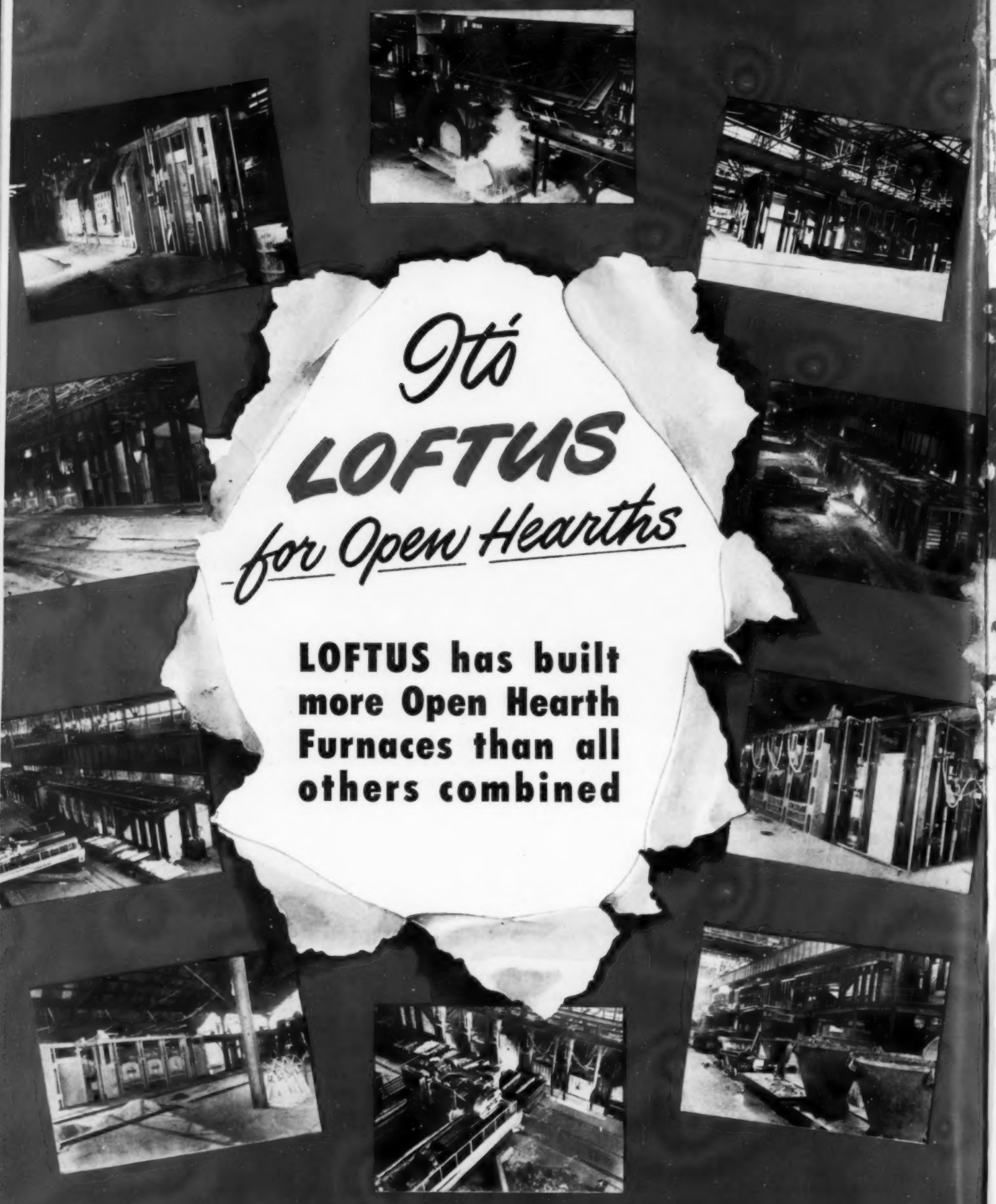
Purposely designed for easy, low cost replacement, the new Rayotube fits all existing Rayotube mountings. This unit requires no protection against high ambient temperature unless its housing temperature exceeds the very high figure of 350 F. Below that point, any previously installed water- or air-cooling can simply be turned off or disconnected.

Temperature control engineers will welcome these and many other new concepts of design built into this highly versatile temperature detector.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad NS3(1)



It's
LOFTUS
for Open Hearths

LOFTUS has built more Open Hearth Furnaces than all others combined

610 SMITHFIELD ST

LOFTUS ENGINEERING Corporation

PITTSBURGH, PA.

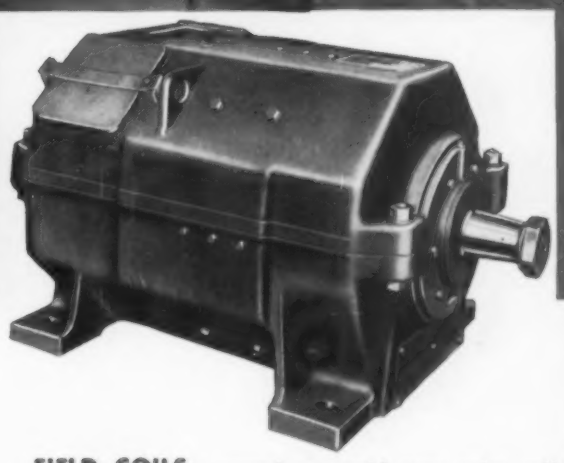
Designers and Builders

Engineers, Consultants, Contractors

NOW more power in the same size package

New

CROCKER-WHEELER
Form W Series 600
MILL MOTOR



The motor built to steel industry specifications

It's got the entire industry talking!

You wanted a more powerful motor, despite the limitations of crane and auxiliary service. Through better utilization of existing space, Crocker-Wheeler engineers were able to increase horsepower without adding to frame size.

You wanted a mill motor easy to get at for servicing. The rugged cast-steel split frame of the new Crocker-Wheeler Form W 600 Series is hinged for easy access to all motor parts.

You wanted longer service life . . . lower upkeep cost. Check the construction features of this auxiliary mill motor—see how thoroughly Crocker-Wheeler design meets your requirements. You'll find a few of these wanted features highlighted at right. For the complete engineering story that's making mill motor news today, write for Bulletin SL-620-1. Advertising Department, Elliott Company, Jeannette, Pa.

FIELD COILS wound on mold over mica cell. Mica washers at top and bottom of coil. Glass tape applied over cell, washers, and coil. Coil is filled layer by layer, during winding, with insulating compound that resists high temperatures, moisture and oil and provides an extremely homogeneous structure. The completely insulated coil is cemented to a steel spool, giving it complete support and rigidity. This design is a Crocker-Wheeler development, proved in previous C-W mill motors.

ARMATURE COILS Conductors are silicone-bonded, double-glass-covered wire. Slot portion of coil insulated with successive wrap of half-lapped glass-backed mica tape which extends around the coil bends and nose for reinforcement. Entire coil taped with closely woven glass tape, then dipped and baked in high-grade insulating varnish.

INTERNAL CIRCULATION Integrally-cast fan blades on rear coil support circulate air through core ducts and between field coils, dissipating heat to frame. Provision is also made for forced ventilation.

ELLIOTT COMPANY

CROCKER-WHEELER DIVISION

Ampere, N. J.

Branch Offices: Atlanta, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Houston, Kansas City, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Newark, Philadelphia, Pittsburgh, St. Louis, Salt Lake City, San Francisco, Seattle, Tulsa, Washington, Wilmington. Representatives in principal cities.

LARGER MOTORS FOR MAIN ROLL DRIVE SERVICE, AND LARGE GENERATORS AVAILABLE FROM RIDGWAY DIVISION OF ELLIOTT COMPANY AT RIDGWAY, PA.

CW-4

ELLIOTT COMPANY,
Advertising Dept., Jeannette, Pa.

Please send Bulletin SL-620-1 on C-W Auxiliary Mill Motors.

IS-450

Name .....

Title or Function .....

Company .....

Address .....

These JOHNSTON CINDER POTS Reduced Slag-handling Costs

Why not service-test them in your operations?

Perhaps you judge cinder-pot service by the number of trips to the slag dump—that's one place Johnston Cinder Pots have established service records.

Your disposal system may require a fast turn-around cycle—a specification made to order for Johnston Cinder Pots which force out skulls after molten slag is dumped.

But the real cost reduction results from the *extra heat-hours* of operation you can expect when you service-test Johnston Cinder Pots and Slag Handling Equipment.

You'll find construction features which

- **resist the distorting effects of unequal expansion and contraction.**
- **reduce wall sag when handling hot pots.**
- **minimize firecracking and checking in pot walls.**

Johnston Cinder Pots have reduced slag-handling costs in many blast furnace and open-hearth operations. Mack-Hemp engineers will show you *where, how,* and *why.*

MACKINTOSH-HEMPHILL COMPANY
PITTSBURGH & MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rails . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abrameen straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers.

Roll users point with pride to this Roll mark

MOLYBDENUM CHILLED IRON ROLLS

ATLAS and ATLAS "B" ROLLS
(Alloy Grain Type)

CLIMAX and AJAX ROLLS
(High Alloy Grain Type)

"X" and "XA" ROLLS
(Alloy Grain Type)

SPECIAL TUBE MILL ROLL

PLAIN CHILLED IRON ROLLS

SUPERIOR "X" ROLLS
(Nickel Grain Type)

AJAX DUPLEX ROLLS
(High Alloy Grain Type)

SPECIAL PROCESS ROLLS
(Chill and Grain Type)

OVER 90 YEARS LEWIS OF ROLL MAKING

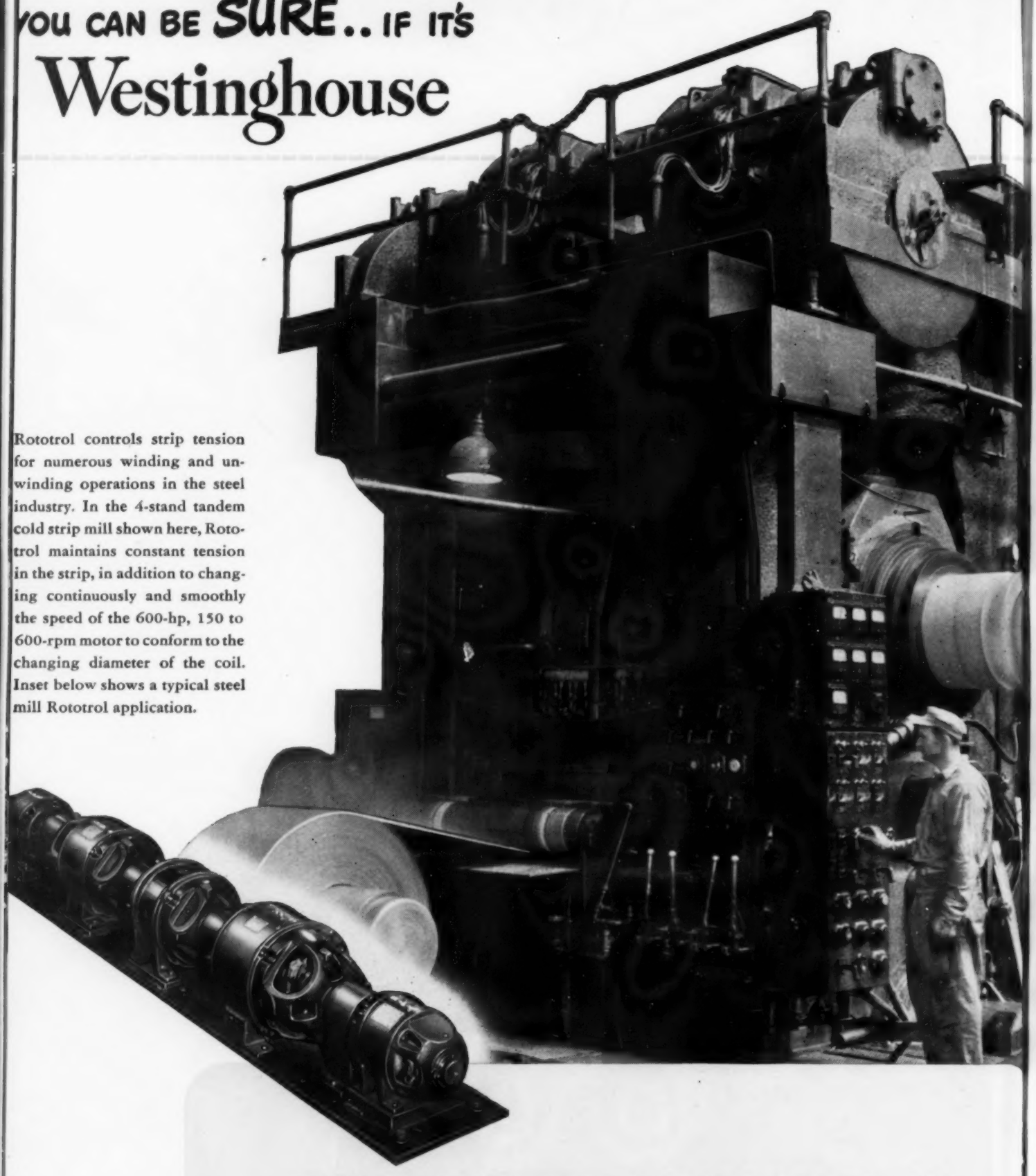
LEWIS FOUNDRY AND MACHINE DIVISION
OF BLAW-KNOX COMPANY · PITTSBURGH, PA.

MANUFACTURERS OF
ROLLS AND ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

Rototrol controls strip tension for numerous winding and unwinding operations in the steel industry. In the 4-stand tandem cold strip mill shown here, Rototrol maintains constant tension in the strip, in addition to changing continuously and smoothly the speed of the 600-hp, 150 to 600-rpm motor to conform to the changing diameter of the coil. Inset below shows a typical steel mill Rototrol application.



INTERACTION OF FIELDS DOES IT ALL

The Westinghouse Rototrol is made exactly like a small, d-c generator, except for several additional field windings. It functions entirely through the smooth interaction of these fields.

Having no mechanical—and very low electrical—inertia, Rototrol responds quickly to deliver the required control power. It brings new standards of perfect performance to almost any repetitive process in the steel industry.

The simplicity of operation makes the Rototrol easy to maintain. It gives unvarying performance indefinitely. It is easily serviced by nontechnical men, and its rugged construction stands up superbly to the rigors of steel mill use.

J-94796

Where else can YOU use ROTOTROL to speed up steel production?

Rototrol—the electrical intelligence—has an outstanding record of accomplishments in the steel industry. By providing smoother, more accurate control of a wide variety of steel processes, it has brought increased production and lower costs.

Here are some of the jobs it is doing:

for skip hoist drives—regulates speed better . . . widens speed range . . . simplifies control.

for blooming mill drives—forces action . . . brings faster, smoother reversals.

for tandem cold strip mills—improves control over stand speeds, acceleration, slowdown and stopping.

for processing lines—matches speed . . . makes possible more rapid acceleration and deceleration . . . minimizes necessary down time.

for flying shear—combined with electronic control, matches speed of shear with that of the mill . . . cuts to close tolerances . . . reduces maintenance costs.

for runout tables and coilers—matches table and coiler speeds accurately with mill speed . . . simplifies operation.

for a-c and d-c generators—regulates voltage . . . holds voltage to preset values . . . returns immediately after changes in loading.

for twin-motor drives—balances load . . . eliminates complex electrical connections.

for rod mills—combined with electronic regulators, matches motor speeds accurately . . . virtually eliminates impact speed drop.

for piercing mill drives—controls stability . . . enables motor to carry high peak loads without pull-out . . . often reduces size and cost of motor needed.

for arc furnaces—regulates power . . . changes electrode position quickly and accurately . . . reduces electrode breakage.

for synchronous motors—regulates voltage automatically . . . adjusts excitation . . . improves power factor.

These applications are suggesting even further uses for Rototrol in the steel industry. There is no foreseeable limit to the improvements possible in steel production methods through better electrical control.

Let Westinghouse applied engineering help you develop and apply new methods and equipment for your specialized requirements. Westinghouse specialists in steel industry applications will be glad to work with your own engineers in studying your operations. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

"ROTOTROL IN THE STEEL INDUSTRY"
This 24-page booklet tells the complete story of Rototrol in the steel industry; its functions . . . its applications . . . its remarkable accomplishments as a control for steel-producing machinery. Ask your nearest Westinghouse District Office for a copy of B-3998.

WESTINGHOUSE

Westinghouse

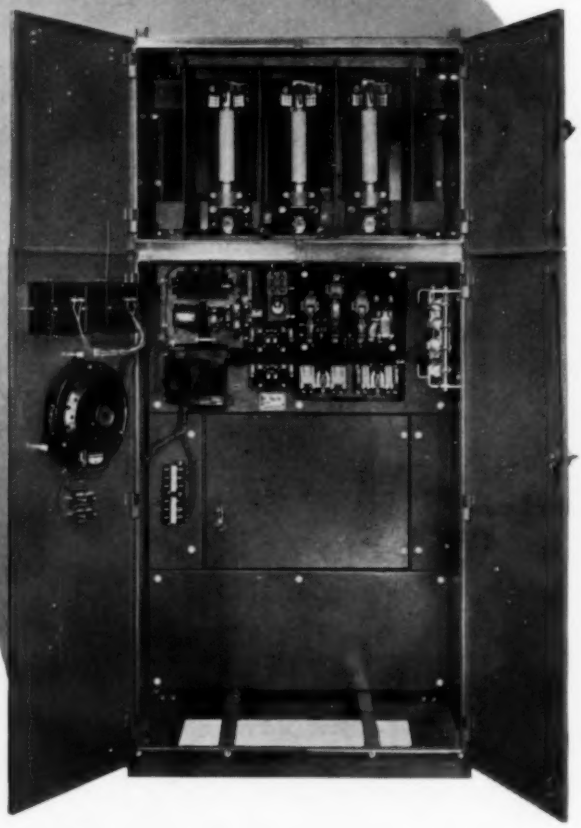
Contact CLARK ..for HIGH INTERRUPTING CAPACITY HIGH VOLTAGE MOTOR STARTERS!

CLARK Synchronous Motor Starters, oil immersed, have current-limiting disconnecting type fuses with an interrupting capacity of 150,000 KVA at 2300 V, 60 cycles, and 250,000 KVA at 4160/4600 V, 60 cycles. They are also available at other frequencies.

There is no mechanical linkage — the direct-acting line contactor operates under oil. Thermal overload and instantaneous under-voltage protection is provided.

Single hand operation on permanent tank elevator, and a float type oil gauge provide easy inspection.

In operation, the motor is started as an across-the-line squirrel cage motor, and accelerates to synchronizing speed with full voltage on the stator winding. The Polarized Field Frequency Relay assures complete and accurate synchronizing of the motor. This relay is constructed to provide field removal in case the motor is pulled out of step, and automatically re-applies the field if motor returns to synchronizing speed within a predetermined time.



A Potential Transformer provides 220 V control circuit, and there are no exposed low voltage control wires in the high voltage compartment.

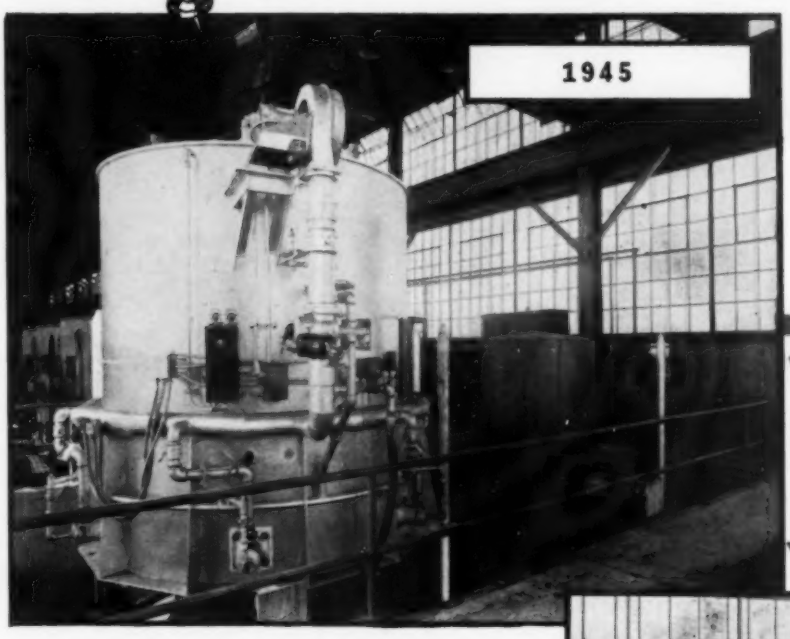
Other CLARK synchronous motor starters are available with Dynamic Braking, in Reversing, Non-reversing, full voltage and reduced voltage types.

Consult our nearest District Office or Agency for details.

THE CLARK CONTROLLER CO.

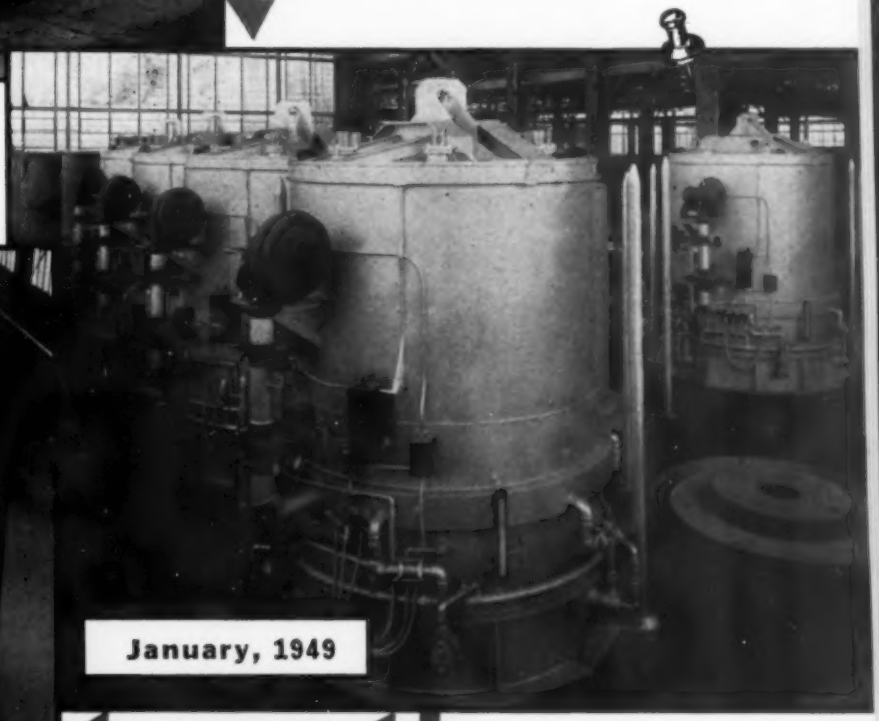
ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

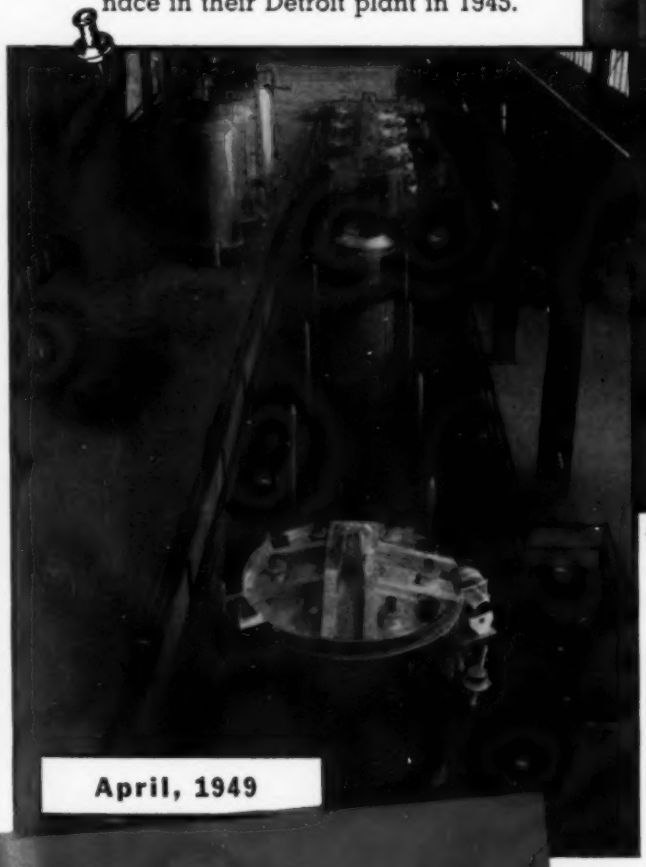
REPEAT ORDERS ARE POSITIVE PROOF OF *Lee Wilson* CONVECTOR FURNACE PERFORMANCE



The Detroit Steel Corporation installed their first Lee Wilson radiant convector coil annealing furnace in their Detroit plant in 1945.

BASED ON the results from this first furnace, the management of the Detroit Steel Corporation installed Lee Wilson convector furnaces to take care of the requirements in their new plant at New Haven, Connecticut. 6 Furnaces 15 Bases 195(Five furnaces and 12 bases capable of annealing ~~3000~~ 6000 net tons of low carbon strip coils per month, were put into operation in this plant in January 1949.





IN THE present modernization of the Detroit plant of this company, a duplicate of the New Haven installation was installed and began operation in April of this year. The first convector furnace indicated the tremendous economy of this design as measured in cost per ton per hour, which justified the selection of this equipment for the subsequent installations in both the New Haven and Detroit, Michigan, plants.

Lee Wilson

ENGINEERING *Co., Inc.*

20005 WEST LAKE ROAD • CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES • RADIANT TUBE HEATING

get ready to revise your casting estimates & specifications

with this new engineering material:

DUCTILE IRON , a very recent & revolutionary

development in the casting industry.

WHAT IS DUCTILE IRON? It is an invention relating to a unique alloy that contains the best features of gray cast iron, malleable iron, and steel with much better physical properties.

DUCTILE IRON IS NEW. Patent was applied for in 1947, and granted October 25, 1949. It is so new that engineers may spend years checking its undeveloped possibilities, qualities, properties, and applications. In the "as-cast" condition it has a combination of properties of an order entirely different from and higher than that obtained in gray cast iron and steel.

Consumers of ferrous alloy castings, and men who specify the engineering materials will be interested in DUCTILE IRON because:

It has a tensile strength of 75M to 90M PSI—
Elongation 2% to 10%—
Yield point 55M to 65M lbs.—
Brinell hardness 175 to 300—
Modulus of elasticity 25,000,000 lbs.—

Illustration suggests the extreme ductility of DUCTILE IRON. This bar, ½" by ¼" as cast, was twisted cold—and it emits a definite, steel-like ring when struck.

HERE ARE A FEW APPLICATIONS:

DIES
ROLLING MILL HOUSINGS
APRON PLATES
GUIDES
TABLE ROLLERS
TABLE GIRDERS
GEAR BOXES
COUPLING BOXES
SPINDLES
RAILROAD EQUIPMENT
PRESSURE CASTINGS FOR VALVES, PUMPS
FURNACE PARTS
MELTING AND HEAT TREATING POTS
COMPOSITE PRODUCTS
MACHINE TOOL CASTINGS
CYLINDERS
PLUNGERS
SLAG LADLES

DUCTILE IRON has excellent founding properties, can be readily cast into molds of intricate design, and has better castability than steel. It has unique elastic properties not possessed by gray iron and can be cast in heavier sections than malleable.

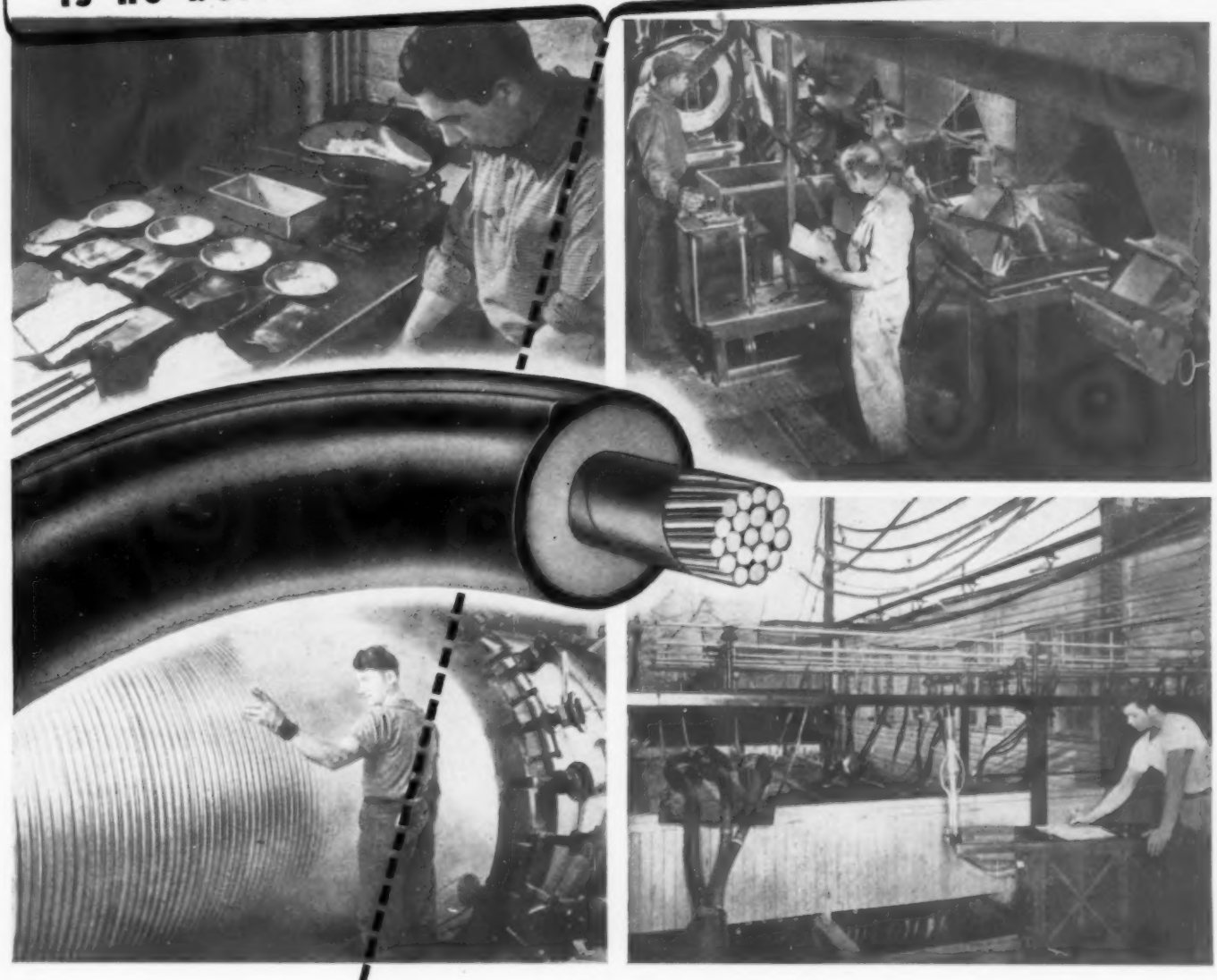
DUCTILE IRON may be applied to the manufacture of a wide variety of ferrous products and articles usually made of such ferrous alloys as gray cast iron, pearlitic malleable iron, ferritic or standard malleable iron, and cast steel.

We are licensed to furnish the steel industry castings with the above properties. Send us your drawings and inquiries, and we will show you how you can profit by using the revolutionary DUCTILE IRON in YOUR products. Licensed under patent from the International Nickel Company

YOUNGSTOWN FOUNDRY & MACHINE CO.

YOUNGSTOWN 1, OHIO

a NEOPRENE SHEATH is no better than its COMPOUNDING*



"Too much stress cannot be laid on the important fact that the best neoprene products are produced by those manufacturers who are skilled in the art of compounding neoprene."

E. I. du Pont de Nemours & Company, Inc.

Neoprene is a raw material. With neoprene it is possible to make a cable sheath that combines resistance to weather, oils, chemicals, flame and ozone – thus increasing the life and versatility of an electrical cable. But the *use* of neoprene alone does not guarantee all its advantages.

The performance of a neoprene sheath depends on experienced compounding . . . the use of ingredients that give optimum characteristics and yet assure secure bonding to the insulation . . . the skill and technique of processing, applying and vulcanizing.

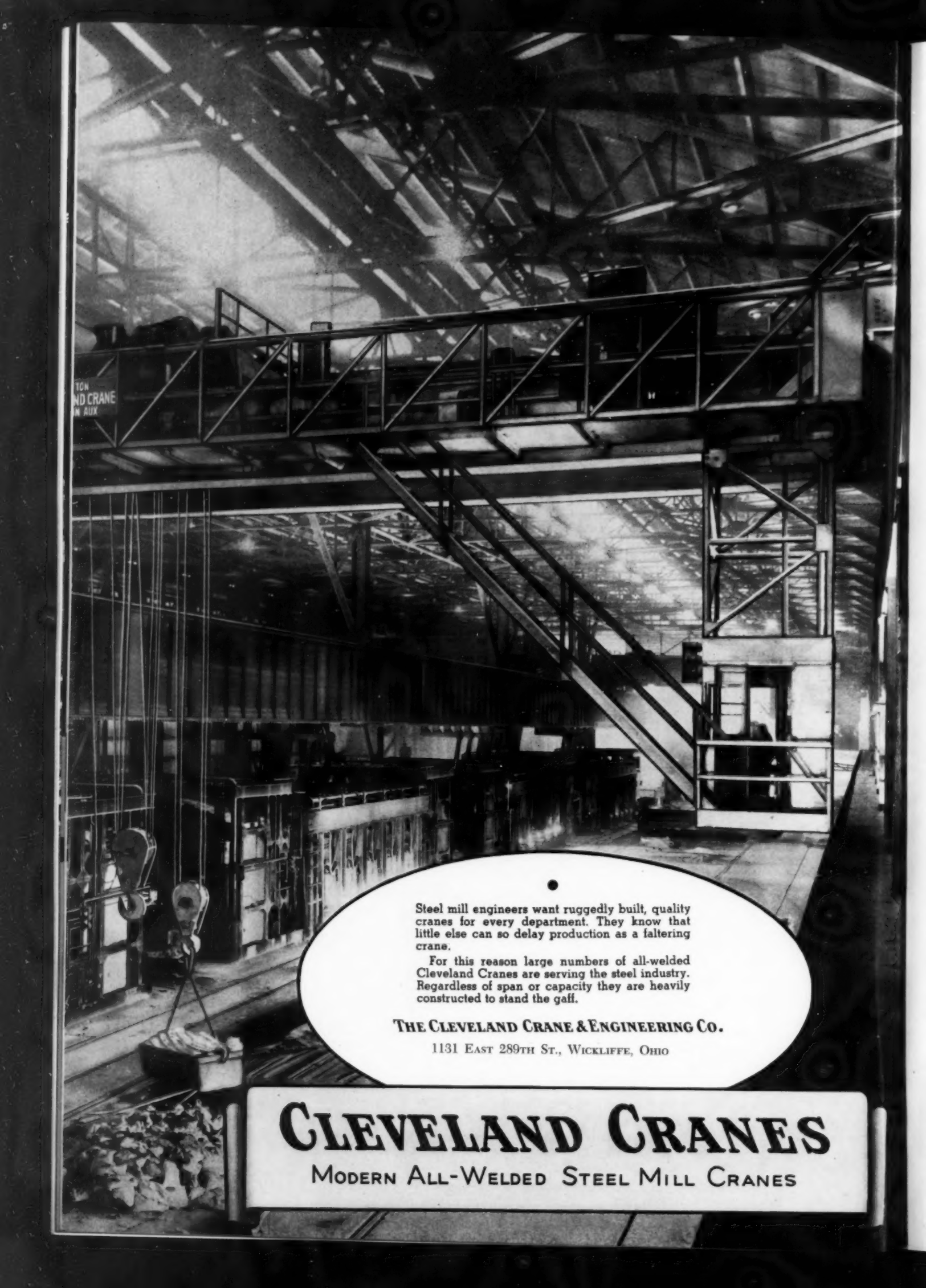
The Okonite Company, originator of neoprene-sheathed cables, has been producing them for nearly 20 years. Okonite's neoprene sheath, called Okoprene, has an unequalled service record under every condition of use. Even at operating temperatures ranging from 75° C to below —18° C, Okoprene remains easy to handle and will not deteriorate. Cables protected with Okoprene do not develop harmful surface discharge.

Remember, it is necessary to compound the raw neoprene material with other ingredients in order to use it. It's the finished compound that counts. And – in these days of high installation and maintenance costs – the outstanding performance of an Okoprene sheath is more important than ever to *true cable economy.* The Okonite Company, Passaic, N. J.

THE BEST CABLE IS YOUR BEST POLICY

8108

OKONITE SINCE 1878 *insulated wires and cables*



Steel mill engineers want ruggedly built, quality cranes for every department. They know that little else can so delay production as a faltering crane.

For this reason large numbers of all-welded Cleveland Cranes are serving the steel industry. Regardless of span or capacity they are heavily constructed to stand the gaff.

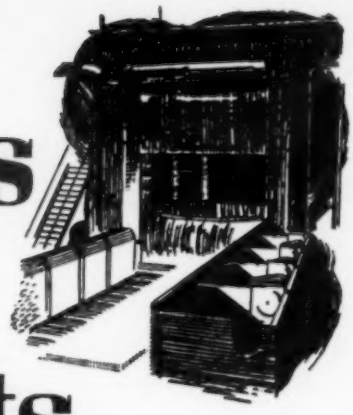
THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 289TH ST., WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts



REACTION of the steel industry to the report of the Joint Economic Committee was immediate and sharp. "An amazing misrepresentation of facts" was the opinion of E. T. Weir of National Steel Corporation; . . . "would bring an end to competition within the industry," commented Republic's C. M. White; . . . "a thinly disguised subterfuge to nationalize a great basic industry" was the statement of J. T. Whiting of Alan Wood Steel Company.

There is no question but that the report, which recommends virtual price regulation for the steel industry, is a twisted, biased piece of propaganda for a socialized industry. It contains no evidence of limitations on competition. It does not admit that prices of many other products are uniform and vary at the same time, nor does it recognize that all prices have moved up in even greater degree than has steel. It merely attempts to condemn by assumption and by innuendo.

Perhaps the committee has forgotten that the real effects of competition can be seen only in a buyers' market, which has not existed during the past decade. At least twice recently, buyers' market in steel has been imminent, but just as production was catching up with demand there were interruptions which our government at least condoned, if not actually encouraged, and which set back the period when competition will arrive. And when such times set in, anyone who denies that competition exists in the steel industry just doesn't know the industry.

▲

STEEL leaders differ somewhat in their outlooks for the industry. Some feel that production will hold near top levels through 1950, while others feel there will be a drop during the second half of the year.

▲

ACCORDING to the president of the United States: "There are 200,000 more mine workers than are needed to produce in continuous employment the country's normal (coal) requirements . . . Men divide the working time, and high wages are necessary to meet the cost of the barest living."

President Truman? No. Warren G. Harding, some 28 years ago.

▲

DURING recent weeks Phillip Murray, John Lewis and Walter Reuther have been sending checks for a million dollars back and forth to help each other support their strikes. What do you suppose might happen if U. S. Steel, Pittsburgh Consolidation Coal and General Motors loaned each other that kind of money to help hold out against strikes? Or what would be said if those companies decided to merge, as the respective unions are currently talking of doing?

▲

SPEAKING at a dinner tendered him by his former students and associates, W. Trinks, professor emeritus of mechanical engineering, Carnegie Institute of Technology, gave several definitions of education:

"Education is the transfer of the contents of the professor's notebook into the student's notebook without passing through the head of either."

"Education is the inculcation of the incomprehensible into the ignorant by the incompetent."

▲

CARROL M. SHANKS, president of Prudential Insurance Company, said "Something new has been added in this country: a philosophy that politics will do quicker and better what used to require sweat and a sense of responsibility."

▲

DURING the recent AISE spring meeting in Birmingham, Alabama, the hotel house organ, Inn Dixie, carried a piece of verse titled "Nacilbuper." An extract:

"To the Nacilbuper
The gay nineties were super —
So much so that everything since
Only makes him wince."

Nacilbuper? Republican spelled backward!

▲

A SURVEY conducted by the Psychological Corp. among small business men showed the following results on a question asking what they found most troublesome: Large competitors, 20 per cent; labor unions, 20 per cent; government bureaus, 58 per cent.

▲

A POOR memory is a great help toward a clear conscience.

▲

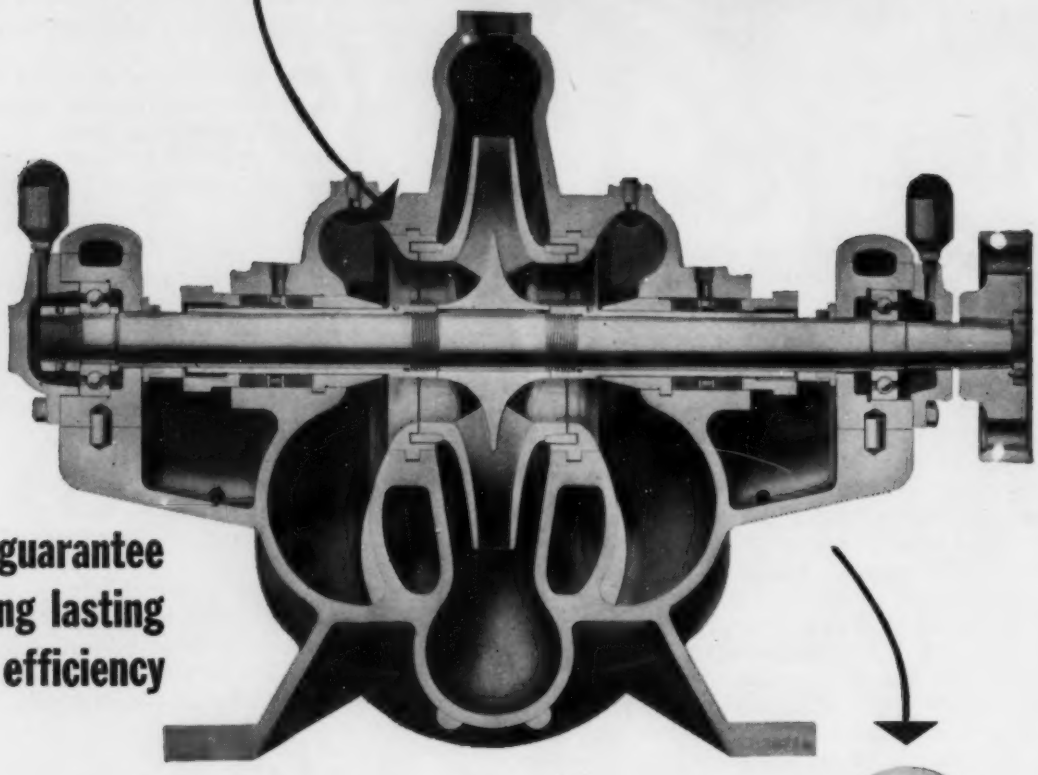
THIS verse from the house organ Typographic should be required material for meditation for all union leaders:

Old King Cole was a merry old soul,
A merry old soul was he.
But because of high wages
He now engages
One fiddler instead of three.

▲

AS of January 1, 1950, the American Iron and Steel Institute reports the annual capacity of the steel industry at 99,392,800 net tons of steel ingots, composed of 86,984,490 tons from open hearths, 5,537,000 tons from bessemers, and 6,871,310 tons from electric and crucible furnaces. Annual blast furnace capacity is given as 71,497,540 net tons of pig iron and ferro alloys, while the industry's coking capacity includes 62,283,490 tons from by-product ovens and 3,185,750 tons from beehive ovens for a total of 65,469,240 net tons of coke per year.

Look ... for the Labyrinth!



it's your guarantee of long lasting efficiency

When you buy a pump equipped with De Laval wearing rings you can be sure that it will retain its high original efficiency, undiminished year after year. That's because leakage from discharge to suction increases but little as the pump wears.

Look at the illustration above and you'll see how the passages through the labyrinth ring retard the flow at the running joint between impeller and casing. The sealing action of these rings does not depend upon the maintenance of close clearances—subject to erosion and enlargement—as does that of the flat ring. As a result, their efficiency is but little affected by wear. With De Laval labyrinth rings the savings grow greater, year after year.

De Laval Catalog 10-16 R describes this and other features that you should investigate before buying a centrifugal pump.

DE LAVAL LABYRINTH RING
Tortuous passages retard flow.

ORDINARY FLAT RING
Close clearances retard flow.

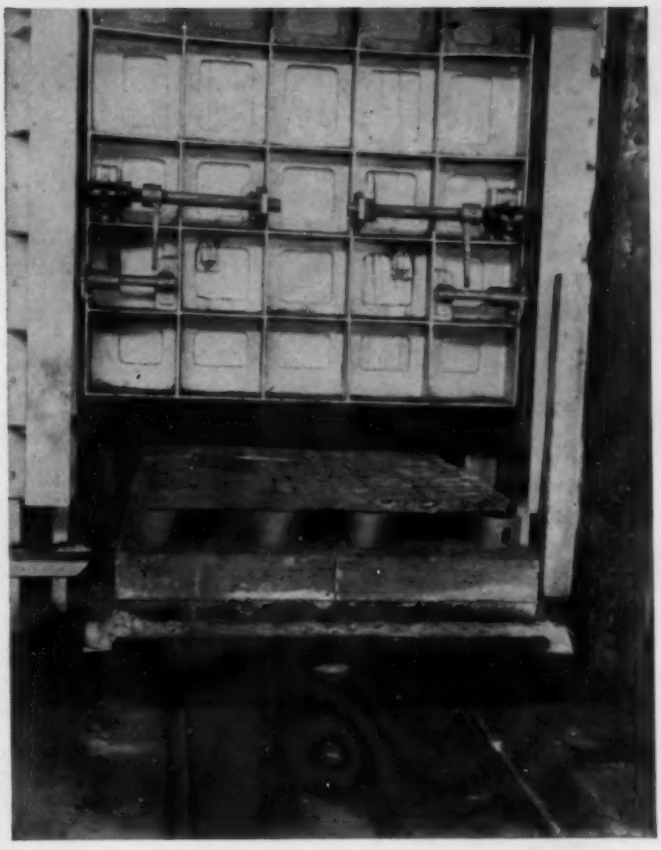
DE LAVAL

DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

10-16

Here's more proof that Lumnite* Concrete Cuts Costs, Saves Time!



Car top made with Lumnite Refractory Concrete entering annealing furnace. Withstands rough treatment, thermal shock of quick quenching after temperatures up to 1700°F. St. Louis Steel Casting Company, St. Louis, Mo.

Core Oven Floors in same plant are made of adaptable Lumnite and crushed firebrick grog. Floors are still in good shape after 7 years' continuous service.

Change to Lumnite Refractory Concrete Boosts Car-Top Life from 6 months to 8 years

Car tops withstand constant rough handling, terrific thermal shock . . . time saved, costs cut. In this plant, car tops carrying heavy metal castings into annealing furnaces failed to stand up for more than six months. Handling these heavy castings subjects the cars to severe punishment. Operating procedure exposes them to terrific thermal shock: cars are in the furnace for hours at 1700°F. Then they are pulled out in the open to cool. In quenching cycles, cars are in the furnace at temperatures rising to 1600°F., then drawn out and quenched from 5 to 10 minutes and immediately sent back into the furnace. Such cycles are usually repeated 6 or more times.

Working with Lumnite field experts, plant officials developed a car top made with a 3" layer of insulating concrete using vermiculite and haydite aggregate, and a 7" top slab of Lumnite and crushed firebrick aggregate. Officials hoped these car tops would last 18 months—thus tripling their life. Instead, they have already lasted 8 years under the rugged handling and thermal conditions outlined above . . . and are still in serviceable condition!

The adaptable refractory: Refractory Concrete made with Lumnite calcium-aluminate cement and selected aggregates may be cast in place in exact sizes, shapes and thicknesses desired. Monolithic construction gives maximum durability, reduces outage time for repairs. Just think of the time and cost saved on this job alone! When repairs are needed, they may be made quickly and easily overnight, because Lumnite reaches service strength in 24 hours or less. Always keep a supply of Lumnite cement on hand. Whether your operation calls for car tops or not, you may well profit from the time-and-cost-saving properties of adaptable Lumnite. Write today for further information to Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

SPECIFY CASTABLE REFRACTORIES MADE WITH LUMNITE

*"*LUMNITE*" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

18-L-29

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"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

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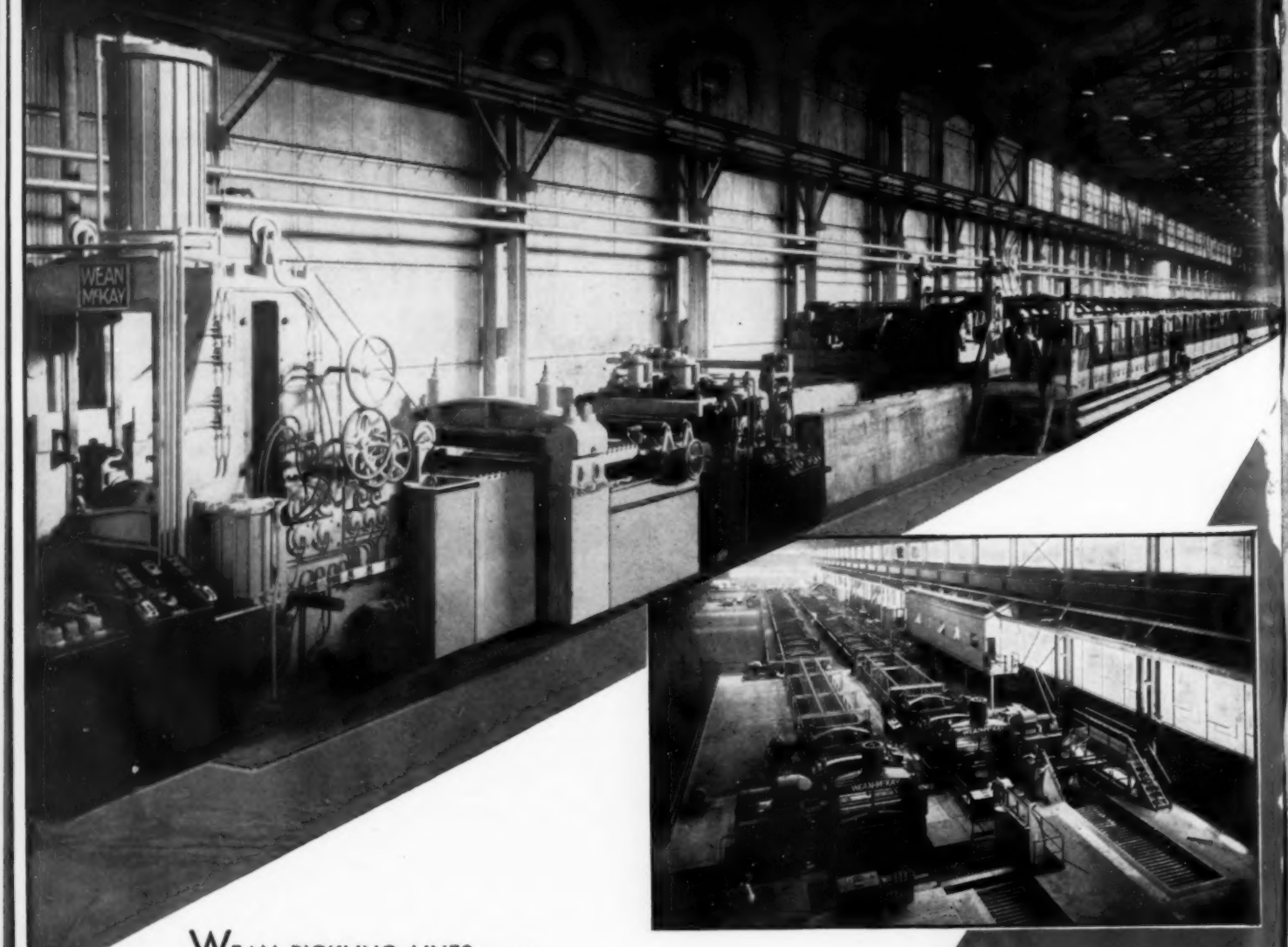

WEAN PICKLING LINES serve users in two important ways. Not only do they assure a better — more uniform — pickling job — but the job is done more economically and profitably.

That's why today the majority of steel makers think of Wean when it comes to sturdy, efficient, high production pickling equipment.

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APRIL, 1950 VOLUME XXVII NUMBER IV

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The furnace that WOULDN'T COMPROMISE

Burdens imposed on an electric arc furnace probe the soundness of every member. Electric currents thunder along near short-circuit levels, temperatures are terrific, physical loads way above rated figures. Lectromelt Furnaces and their auxiliary equipment have proved themselves in that kind of service.

Some years ago, when buyers were asking "How much?" before "How good?", Lectromelt set out to build a competitive model. Construction was to be lightened up generally. But as Moore, inventor of the Rapid Lectromelt Furnace, watched it grow, he wasn't happy. The furnace wasn't Lectromelt.

The "competitive model" was never built. The finished furnace had all the refinements developed by Lectromelt throughout the years. The wisdom of this thinking is reflected in these facts: Lectromelt Furnace users buy mighty few replacement parts. Furnaces installed many years ago are still going strong.

Refusal to compromise is an important point to look for when considering an electric furnace. For helpful data, write for Bulletin No. 7. Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

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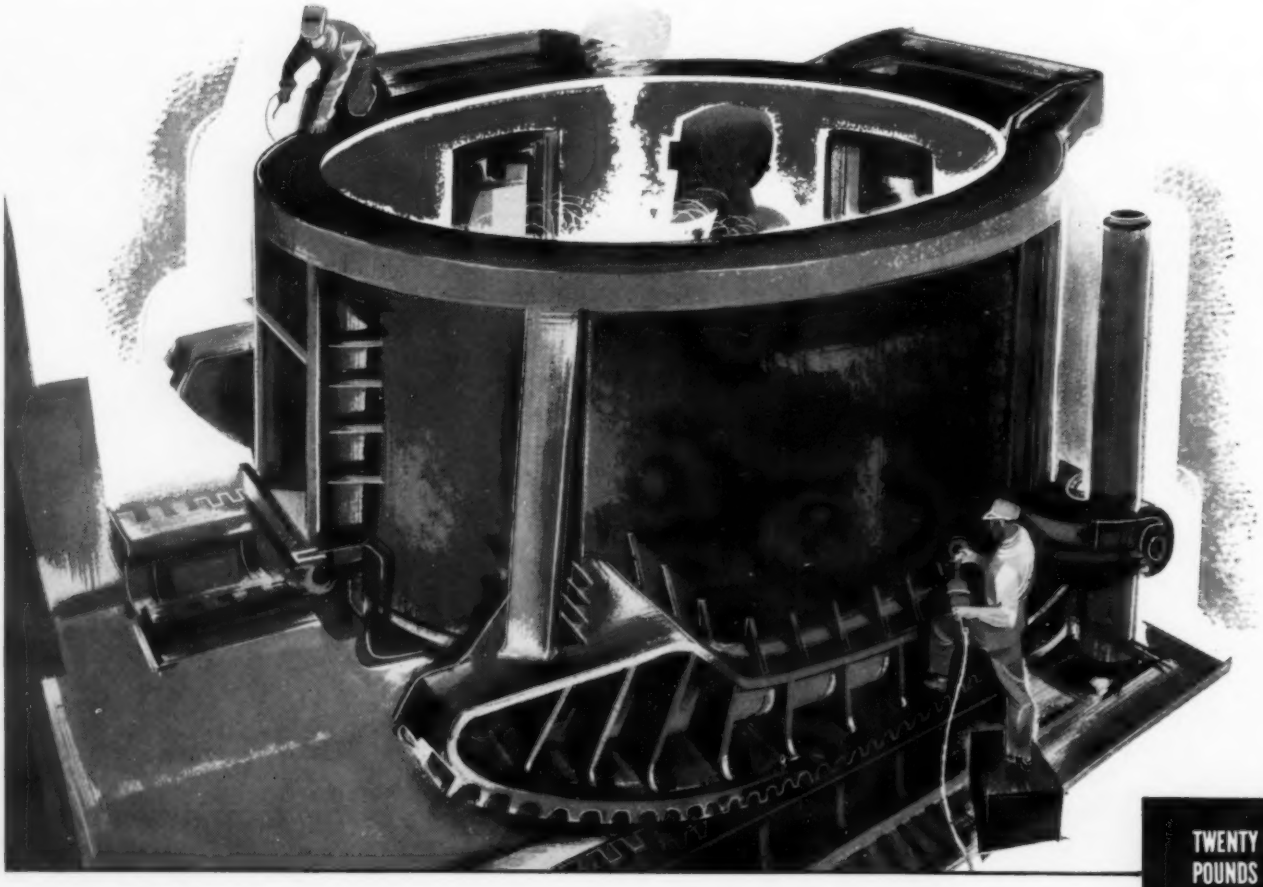

WHEN YOU MELT... MOORE RAPID *Lectromelt*

RELATIONSHIP OF MATERIAL HANDLING TO PRODUCTION

. . . . careful and detailed scheduling of production is combined with efficient handling by radio-dispatched straddle trucks to effect material production economies . . . .

By JAMES S. FREESE and FRANK C. WIER
Production Manager Superintendent
Material Handling
Steel and Tube Division
The Timken Roller Bearing Co.
Canton, Ohio

PART I

By JAMES S. FREESE

▲ PRODUCTION control of finishing operations, as it is now known in the steel and tube division plants of the Timken Roller Bearing Company, is the scheduling by order, individual bales through each processing department from the hot mills through the shipping department under the direction of the production department. Products produced are alloy bars, seamless steel tubing, stainless, tool steels and various specialtity.

The old scheduling plan will be briefly covered prior to discussing the present production control system.

The billing department issued an order based on information furnished by the sales department. Before duplicating and distribution to the operating departments, the order was processed by the technical departments, who supplied data pertinent to fabricating.

Each operating department had clerical workers who cataloged the orders and scheduled material through their respective department. In each department, these orders were filed in large looseleaf book binders.

The nature of the old records required the issuance of many change notices—actually more change notices than orders—which were burdensome to the operating departments since they had to exercise great care to be sure all change notices were honored in connection with the orders to which they pertained.

Before introducing the present control system in the finishing departments, difficulty was being experienced in processing orders completely. Piles of in-process steel were high, causing relocating of piles by the cranes to locate certain orders, bales of steel were lost; there was lost motion and wasted time and effort in the mill because of the complexity of the scheduling method used and congested piles of material which resulted.

Detailed schedules were issued to the operating departments daily by the production department. However, as has been mentioned, the clerks in the operating department had complete sets of orders and change notices, so they were in position to do the effective scheduling from their records rather than being compelled to work from the detailed scheduling provided by the production department.

Although this system had weaknesses which did not furnish as good service to customers, or as efficient utilization of personnel and plant capacity as it was felt there should be, it was the system that was used to produce the steel for Timken tapered roller bearings and seamless tubing and bars for steel customers.

Nevertheless, it was felt that the system could be better. It was believed any successful plan would have to produce orders complete through each department. To effect a better scheduling plan, improved material handling was required. High stock piles had to be reduced and one central scheduling unit for all departments was of prime importance. The starting point of scheduling, however, obviously had to be a better order for scheduling purposes.

It was possible to devise a form that combined the sales order and mill scheduling form and meet the needs of the production department for a better scheduling tool. This new form is used in a way that goes far to eliminate the change order notices which were so numerous and confusing under the old plan. Orders follow the same route as before until they arrive at the hot mill schedule clerks. At this point they are held until the order is ready to be rolled on the mill with all changes being posted on the original hectograph order prior to duplication.

The change of methods for material handling have been of great benefit to the scheduling from this point on, and will be discussed in detail by Mr. Frank Wier a little later on.

The clerical personnel scheduling finishing operations in the operating departments were transferred to the production department. This change centralized responsibility where it belonged and made possible better control of the flow of material. The production department receives three copies of the orders, and the inspection department one. The operating departments no longer have to deal with bulky copies of all orders which contain much information of no interest to them.

One copy of the order is prepared on card stock. This is the master order card. The front side gives the order and delivery specifications and routing with all necessary supplementary instruction. The reverse is the

STEEL & TUBE DIVISION — THE TIMKEN ROLLER BEARING COMPANY — CANTON 6, OHIO, U.S.A.

CHICAGO — BMJ — C-39017 — 10/5/49 — 24752 — 10/5/49

SEAMLESS STEEL TUBING — FRT. VIA L,V,R,P, — X

TAG P.O.NO., HT.NO., SIZE,TYPE DIE STAMP HT.NO. ON ONE END, PAINT BOTH ENDS RED.

OUR PRICE IN EFFECT AT TIME OF SHIPMENT WILL APPLY. PRESENT PRICE IS $

F.O.B. — TERMS

SOLD TO: JOHN DOE CO., CHICAGO, ILLINOIS — SHIP TO: SAME-DETROIT, MICHIGAN

SOLD TO: JOHN DOE CO. — PRODUCTION ORDER 24752

X-3-4535-X (1804)

18629 BEARING RACES — MACHINING ANTI-FRICTION RACE

ANNEALED-COLD DRAWN

CONF: IDENTIFY BY HT.NO.

T.F.W. 12.97 LBS. TAPERED BEARING.
TUBES TO BE GIVEN A LIGHT COATING OF PARAFFIN OIL.
TUBES TO BE FREE FROM LAPS, SEAMS, PIPE, POROSITY, SEGREGATIONS, SCRATCHES AND PITS.

CF 4620 BEARING QUALITY — 4620 — 5-8

8,000 FT. 103,760 LBS. — 2.832" OD X .527" WALL — 13-17 FT. AIM 15-17 FT.

3.062 X .562 & GR 12-3-1/16 — 16 FT. — TO 5 FT. 5% BY WGT.

O.D. PLUS .010" MINUS .000" — PLUS OR MINUS 7-1/2%

				C	Mn	P	S	Si	Cr	Ni	Mo
				.17 .22	.35 .65	.04 MAX	.04 MAX	.20 .35	.25 MAX	1.65 2.00	.20 .30
66999	356 ALL	3x247	59690	.19	.52	.023	.018	.27	.17	1.82	.28
66996	151 ALL	4	60560	.20	.61	.019	.020	.29	.15	1.91	.27

OCTOBER — OCTOBER WK OF 10/17

HOT CROP ONE END

O.D. 2.832-2.842
W 492-532-572
I.D. 1.773

P.O. 24752 — 1 C.D.

RED — 2-3504

#11 - SLUG 50-50% PLUS ONE 1-1/2" SAMPLE PER BALE FOR CANTON MET. LAB.

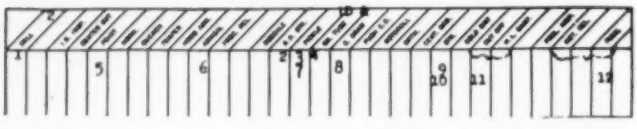

Figure 1 — This sales order combines scheduling for hot mills and finishing departments.

process routing record to which postings of stock in process by bales are made.

The other two copies are sent to the cold draw and annealing departments where they are checked for process routing. If changes in routing are made, they are noted and cleared through the process routing department, so that subsequent orders will be correctly routed.

One copy of order is used by the cold draw department for the preparation of tools and mandrels, and one copy is returned to the production department to create a numerical cross index, while the master order card is filed by customer's name.

A finishing department operating schedule card showing sequence of operations is prepared for use as a work sheet to each operating department. This card is designed so that from one hectograph original, one schedule card and one machine load card are duplicated for each processing operation. The machine load card is used for estimating processing time and designating the equipment on which work is to be done.

We use two 100-pocket scheduling boards. Each pocket represents thirty-one 24-hour days of one machine. One board represents the current and the other the following month. The process time estimator cuts these machine loading cards, to indicate the allowed time for the operation. These cards are then tucked into the pockets to allocate machine time to specific operations on individual orders.

Each card in place blocks off specific hours of machine time. It is impossible to schedule two or more jobs simultaneously on the same machine, and so capacity is not over-sold. If we find that an order cannot be handled in time to keep a delivery promise, because all available capacity is already scheduled, this information is relayed to the sales department. The delivery is then rescheduled to the earliest possible time and the revised delivery date noted on the master order card.

Scheduling orders to the operating departments is done from the scheduling board. The date that an operation is to be done is stamped on the machine load and the schedule card, the latter being sent to the operating department. Schedule cards are delivered and picked up from operating departments every hour, 24 hours per day.

The recording section in the mill notes work completed on the schedule cards. The machine load card is pulled from the scheduling board pocket as completed cards are returned from the mill.

Finishing department schedule cards are not sent to the operating department until the stock has been moved to it. Work and schedules move together, instead of schedule cards getting way ahead of material. There is no confusion or uncertainty about what material will be available for processing or which orders will be run on which machines during specific shifts and dates. The visual control in the production department eliminates all confusion and uncertainty.

If, for any reason, an operation is not completed during the shifts for which it was scheduled, the card remains in the pocket after the time has elapsed. This, in itself, is a warning that order is behind, and indicates

Figure 2 — A time estimating card is used to estimate time for each operation. It is inserted into production control board with one card for each operation.

FINISHING DEPARTM

FORM 3706 — WK 10/17

CUST. JOHN DOE CO. — CONDITION ANNEALED - COLI

ORDER 24752 A

OPER.

MACH.

QUANTITY 8,000 FT. 103,760 LBS.

FIN. SIZE 2.832"OD X.527"WALL

SPEC. 4620

HOT ROLLED SIZE 3.062 X .562

BALES AND WEIGHT 6 49,476

HOURS

FINISH SIZE O.D. 2.832 -

HEAT	BALE	PCS.	WEIGHT	
66999	3330	30	7980	1

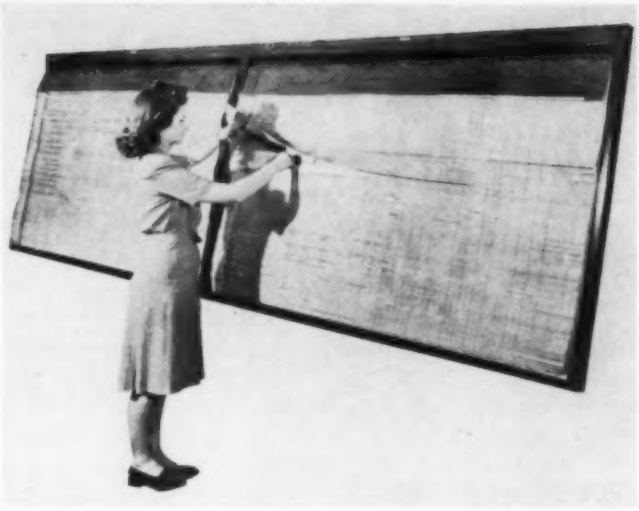

Figure 3 — Machine load cards are inserted in production control board pockets based on delivery requirements.

that a delivery promise is in danger of being broken. Rescheduling is not difficult for it is only a matter of shifting unit machine loading cards to available time. Visible control has vastly simplified scheduling of finishing operations.

Benefits derived from centralized production control have been:

1. Orders are shipped complete at one time. Better delivery performance is attained as well as improved delivery status information to our sales department.
2. By processing orders completely at each operation, it has been possible to reduce costs by fewer tool changes and set-ups on machines.
3. Closer in-process inventory controls have eliminated lost bales, thereby reducing overall costs.
4. The incorporating of scheduling personnel has resulted in improved efficiency under production control with reduced personnel.
5. Machine loadings ahead of all operating units are quickly determined by visual inspection of visible scheduling pockets. Weekly, the total machine hours per operating unit is furnished the operating supervision. These are used to determine future work schedules.

Material handling which stores material in an outside area of the plant has reduced the size of piles of steel inside the plant to a more accessible working condition. Stock may be held outside until the production department is ready to schedule an order in process. If congestion should develop inside the plant for various reasons, the condition can be relieved at once by movement of stock temporarily to an outside area. It is now possible to stand in one end of the plant and see through to the other end several blocks away, and feel confident that better production control and material handling makes this condition.

If the production department had a slogan, it would be "Assign clerical personnel to do the planning and scheduling of a plant and let the operating departments operate."

Figure 4 — The finishing department operating schedule card is used as a work order to each processing unit. One card is duplicated for each operation.

FINISHING DEPARTMENT OPERATING SCHEDULE CARD

WK 10/17

JOHN DOE CO. | ANNEALED - COLD DRAWN | SCHEDULED FOR - MACHINING ANTI-FRICTION BRGS.

24752 A

QUANTITY 8,000 FT. 103,760 LBS. | LENGTHS 13-17 FT. AIM 15-17 FT. | SHORTS TO 5 FT. 5% BY WGT.

2.832" OD X .527" WALL | 4620 | 6 49,476

3.062 X .562 - 16 FT.

O.D. 2.832 - 2.842 W 492-532-572 I.D. 1.773

HEAT	BALE	PCS.	WEIGHT	OPERATION	PROCESSING DATA
66999	3330	30	7980	1 - #2 MILL	9/28 - SCRAP RED
				2 - BD STR.	
"	3331	30	7980	3 - PIC.	
				4 - I.D. & GR. TUBE	
"	3332	31	8240	5 - POINT	
				6 - ANNEAL	
"	3333	33	8770	7 - PIC.	
				8 - C.D.	
"	3334	30	7980	9 - STR.	
				10- STR.	
"	3335	32	8510	11- CUT OFF	
				M.R.	
				12- FINAL	INSP.
					#11-SLUG 50-50% PLUS ONE 1-1/2" SAMPLE PER BALE FOR CANTON MET. LAB.

PART II

By FRANK C. WIER

The greatest single requirement to physically implement the movement of material outlined by Mr. Freese is flexibility. This flexibility may be obtained in several different ways with various kinds of equipment.

The problem of improved material handling at Timken was undertaken after accepting as a basic premise the need for greater mobility of both material and equipment. Existing plant conditions required this approach due to limitation in existing building area and the excessive investment cost involved in expansion.

The method used in the Timken plants to obtain this objective is by using outside storage space with straddle trucks to handle unit loads. While this method may not attain perfection in all points, it is felt that it is

Figure 5 — Straddle truck has a load of in-process tubing ready to go into the finishing department.

Figure 6 — Laydown area for in-process bars and tubes shows arrangement for identification of materials so that straddle truck driver does not need to dismount from his truck to get the right load.

more advantageous than the methods previously employed.

Before the installation of the present system, a plant railroad system was used. If enough trackage was available, along with enough cars, and a corresponding amount of motive power was in service at all times, a reasonably good job of movement and storage in cars could be attained. This was also contingent on sufficient trackage for unloading and reloading in all operating departments, in other words, so long as there was a preponderance of equipment to handle the tonnage, the plant work was satisfactory.

It is obvious that this method of movement and storage requires an extremely high capital investment and high operating costs to attain the required storage and movement for a good operating condition, because there can be a requirement for so much standby time for operating crews, and because storage in railroad cars is inefficient, in that the more storage required, the more switching is required to deliver a particular car at a given spot at a given time.

The same end results can be attained in a plant having unlimited building storage space equipped with overhead cranes. In attaining the proper end result, a great deal of rehandling is required under this system because of the necessity of vertical piling of material.

Figure 7 — Piercing billet storage yard shows arrangement for identification of material.

This type of rehandling by overhead crane methods is expensive, because it is necessary to use manpower to hook up and unhook each load for overhead crane handling.

If carried too far as related to crane runway length and multiple overhead cranes, it may result in the necessity for rail transfer handling between cranes, or for the crane carrying a load from one end of a building to the other to immobilize the rest of the cranes on that runway by running them ahead of it, so the load bearing crane can take its load to its destination.

Whether by railroad, crane, or transfer track, any attempts made to improve or modify our handling system always bogged down because of the limitations of the flanged wheel running on a steel rail. This can best be explained by saying that this type equipment is limited to fixed movements. It is impossible to move sideways or to turn around.

In the present system, pneumatic tired vehicles are used which permit a fluid condition as related to movement of material.

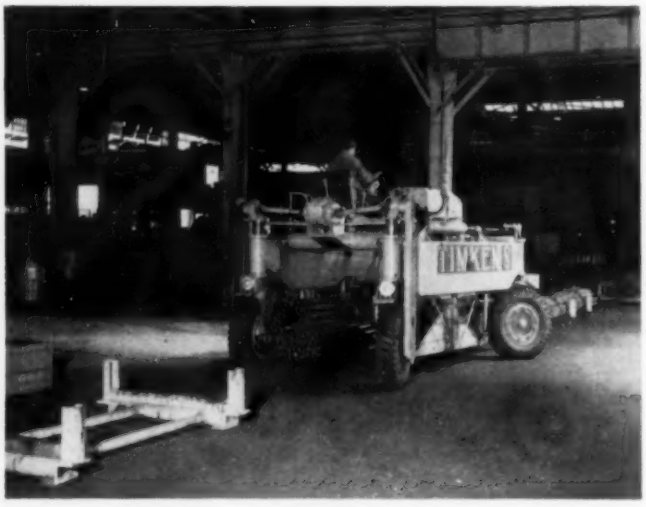

Figure 8 — Straddle truck used for inter-building transfer of in-process material. Detail of bolster construction is shown at left.

In discussing this method the procedure is as follows:

Bars and tubes coming off the mills are formed into bales, and loaded on to what are called bolsters to form a unit load, either at the mill or after being hauled from one plant to another by railroad system. These unit loads are then placed in outside storage by pneumatic tired straddle trucks. In some cases, to satisfy the requirement of the material control system, some part of the material being handled will be taken directly to the finishing operation. The advantageous part of this system is the fact that any part of any order can flow directly to finishing, or into storage, as indicated by the production department scheduling system. This divorces the flow of material coming off the mills from the rate of flow into the various finishing operations. It is well known that the variance in rate of flow between these operations is one of the principal stumbling blocks in the attainment of maximum production by all the various units in a steel mill.

Once the material is formed into a unit bolster load no further handling is required except by the straddle

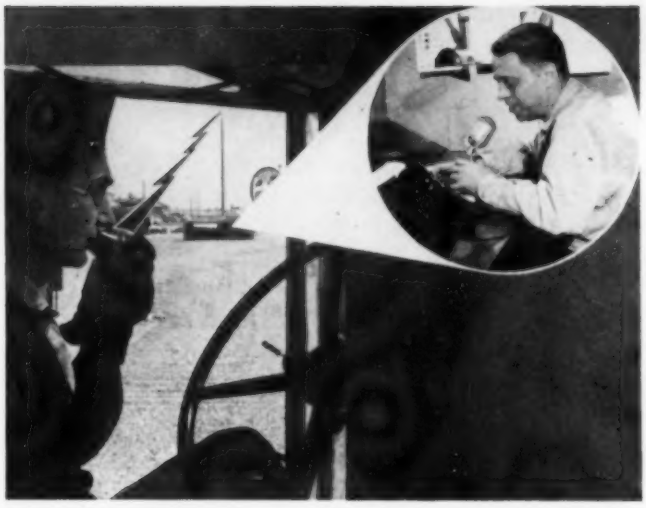

Figure 9 — Dispatcher and straddle truck driver use two-way FM radio with dispatching station in the background.

trucks. With the use of a proper laydown system there is no hunting for material, no hooking up and no unhooking required.

The outdoor laydown system consists of a series of rows of laydown places, each row being designated by a letter, and the places in the lettered rows being designated by numbers.

As unit bolster loads are put in place in the yard by a straddle truck operator, he records on the original mill manifest the location of each load by row letter and place number. When the laydown of a particular shipment is finished, the straddle truck operator turns this manifest over to the material control man, who is in charge of feeding the material into the subsequent operations. When the material is required for further processing this laydown location is telephoned to the material handling department radio dispatcher, who in turn transmits the information to the straddle truck driver by means of two-way radio. He is then able to obtain the desired material without any other assistance, by picking up and delivering the load which he finds in the designated location. This system provides the utmost flexibility, as any load of two or three bales, weighing from 10 to 15 tons, is immediately available without hunting, car shifting, hooking up, unhooking, digging out from the bottom of vertical piles, changing from one crane to another, without having occupied valuable building space, without tying up railroad cars and crews waiting to shift them, or without any of the usual hindrances to the free flow of material.

In using a system such as the one described, it is essential that the straddle trucks be adequately dispatched and their activities be fully controlled at all times. It was found necessary to install two-way frequency-modulation radio control system to regulate use of the straddle trucks. By this means, full utilization of the trucks can be obtained in all parts of the Canton and Gambrinus plants. Although the two plants are located three miles apart, the straddle trucks are adequately dispatched from one central dispatching station located at the Gambrinus plant. Calls for service come into the radio control station by telephone from all parts of both plants. All orders given to the straddle trucks are by radio. No physical contacts are necessary, and in order that the dispatcher may have control of all movements, and be able to properly appraise the work load, no orders are accepted by the straddle truck operators from any one, except through the radio dispatcher. By adhering to this policy, confusion is eliminated and an effective control of the straddle trucks is maintained without any trucks working for any one on an assigned basis.

Since a system has been worked out where it is unnecessary for the straddle truck operators to make physical contacts to receive orders for work to be done, and similarly unnecessary for them to dismount from the truck to locate material in the storage yards, there remained but one operation that impeded the free flow of our materials. This was the opening and closing of doors to get the material in and out of the buildings. This was overcome by the installation of autosonic door and gate control, which permits the straddle truck operator to open a closed door, or close an open door, by pressing a button located in his operating cab. This intimate door control also minimizes the length of time the door needs to be opened during the cold weather of winter months, and greatly reduces the heat loss during these months by the frequent delivery of loads of material into the buildings.

In the development of a material handling system it has been deemed advisable to set up a material handling department which functions as a separate and fully integrated unit along with the other operating units. This is necessary in order to attain the desired cooperation between producing units, and to develop the best

Figure 10—Door uses control device for opening or closing by pressing a button in truck cab. The microphone is shown above the door at the top of the picture.

possible method of moving the various materials by means of mobile material handling equipment, to achieve maximum production in all the various units regardless of the handling problems involved.

This maximum production cannot be achieved, regardless of the efficiency of the material movement, unless the efforts of the producing departments are properly guided and coordinated, by an alert and efficient method of scheduling operations.

DISCUSSION

PRESENTED BY

W. D. SULLIVAN, Assistant Works Manager, Babcock and Wilcox Tube Co., Beaver Falls, Pa.

JAMES S. FREESE, Production Manager, The Timken Roller Bearing Co., Canton, Ohio

FRANK C. WIER, Superintendent Material Handling, Steel and Tube Division, The Timken Roller Bearing Co., Canton, Ohio

GEORGE C. BRAINARD, JR., Assistant Superintendent, Cold Strip Mill, Youngstown Sheet and Tube Co., Youngstown, Ohio

J. J. NICOLAY, Industrial Engineer, Republic Steel Corp., Warren, Ohio

JOHN W. KIGHT, Assistant Chief Industrial Engineer, Spang-Chalfant Division, National Supply Co., Ambridge, Pa.

W. D. Sullivan: I am jealous of Mr. Wier and Mr. Freese. We, in Beaver Falls, could not have these straddle trucks and very few of us in the Pittsburgh district could use them. This is because they have nice level plains in Canton and can handle material in a space that looks like acres and acres. When we have an acre, we have to put loads on top of that acre about four deep.

I would like to ask Mr. Freese a few questions. You mentioned that orders follow the same route until they arrive at the mill schedule clerks. If the master copy of the order is held and not duplicated, how do you determine when the order is to be rolled, according to the set up sequence?

James S. Freese: We operate from what is known as a sales schedule. Every order on our books is cataloged by the steel sales department, and the issuing of an order is only a functional matter of supplying the customer's information to our billing department.

The sales department issues a schedule with delivery data which is our authority to process the order. The schedule often accompanies the order on rush items. No order is started in process without this schedule.

W. D. Sullivan: There is one more question I should like to ask. You cite the benefits from your system in having orders complete at one time. We have numerous customers who may give us fifteen, twenty, or thirty orders for shipment at one time. I notice on your board you show a large-sized order—on the schedule you showed there was over fifty tons. We have numerous orders for fifty and hundred-pound lots. How do you control orders like those?

James S. Freese: The amount of the order doesn't make any difference. No more than eight bundles of material are put on one schedule card, therefore the same order may be on several cards. The slow moving operations are cut to as few as two bundles to a card as we do not desire to have more than 24 to 48 hours work on any one card.

Every order follows the same sequence, whether it be for one bundle or 100 tons.

W. D. Sullivan: There is one question I wanted to ask of Mr. Wier. "In the wintertime, when you have bad weather conditions, how does that affect your trucking conditions?"

Frank C. Wier: We will soon be going into our fourth winter. We have had to scurry around a little, the same as the state highway department has to do and you have to get your car out of the garage in the morning if you have a heavy snow fall. We have not yet failed in the processing of an order due to the weather.

George C. Brainard: At the Campbell works, we do not have the area around the plant to enjoy the possibility of this particular program. However, I was very much interested in the authors comments on storage and fixed and fluid movement, because, due to our limited area in Youngstown, we do have to go to vertical storage and, of course, when a big inventory is built up, it means a great deal of digging to get current orders out. There is no question about the fact that it costs a lot of money, takes a lot of time, and incurs delays on various operating units.

I would like to ask Mr. Wier, in connection with the question brought up on inclement weather, what he does to protect his material when his storage is outside, and if he does protect it, what his approximate cost per ton figures are?

Frank C. Wier: At the present time the only stock that we store outside is in-process material. In our particular plant, for a storage time not exceeding a few days, we do not incur any damage in subsequent operations; therefore we have no cost.

George C. Brainard: I would like to ask Mr. Wier how they figure the storage space that is required to take care of the material that is in process. Is there any particular basis for figuring the square feet area, or do you determine that through experience?

Frank C. Wier: We determine it through experience. We have found it takes so many square feet of a certain pattern to accommodate a load and, of course, we have to estimate the loads that any inventory may require. The whole thing is on the basis of experience and nothing else. There is no pattern.

George C. Brainard: I would like to ask Mr. Wier whether or not this system is used for an intradepartment storage system; in other words, within one department, where you have successive operations, do you try to store outside on each succeeding operation?

Frank C. Wier: No. Not on each succeeding operation. On the other hand we do not let any excessive accumulations occur either between departments or in departments without taking the excess to outside storage.

George C. Brainard: I have another question I would

like to ask at the present time. I have had some experience with communication systems during the war. Sometimes they were successful and sometimes they were not, even under the best laid plans. What success do you have with your two-way FM radio communications system as concerning interference with buildings, high tension lines, transformers, and other obstacles that may be in the way of transmitting waves? What kind of maintenance do you have on your communications system?

Frank C. Wier: Up to now we have found but one spot in either plant that gives us any interference. We have a dead spot in one building about a hundred feet long. It is so small it is not worth even trying to find out what causes it. Other than that, we operate inside several buildings, each several hundred feet long, and communications are perfect.

Maintenance is carried on by an outside, non-company, licensed radio man. Our method of cutting down delay time when we have difficulty is to change out a whole set. We do not attempt to tinker with a set while it is installed in any of the trucks. We carry spare sets, and the whole set is changed.

George C. Brainard: One more question on that, now that the question of maintenance has come up. "How many tractors do you have to have in service to carry out this program, and how many loads per tractor hour do you figure on so far as transportation is concerned.

Frank C. Wier: The capabilities of the straddle truck are related to distance. I would estimate that on a haul of a hundred feet, and with uniformly heavy loads, upwards of six to eight hundred tons an hour could be moved. A complete round trip can be made every six minutes, on a half-mile haul, if there is no interference.

J. J. Nicolay: Having had the opportunity of visiting Mr. Wier's plant and viewing the operations he has described in his talk today, I have only one criticism to offer. He is guilty of understatement. It gives one an uncanny feeling to see four, five or six straddle trucks going from one part of the plant to another under no apparent direction. Two-way radio control of materials handling equipment is something we could all dream about.

The combination of an efficient production control system and the use of proper flexible equipment for materials handling has undoubtedly affected a great savings for Timken at a relatively small expenditure. Another extremely valuable benefit was realized. In several locations, trackage has been completely removed, giving additional floor space for operations and relieving yard congestion.

In several comments made this afternoon, complaints were made on lack of room or two many hills for the operation of straddle trucks. It would seem that if there is room enough to operate a railroad system, the possible use of straddle trucks should be investigated. There is no doubt in my mind that straddle trucks can handle most steel plant materials in process quicker and cheaper than any rail handling equipment. However, as Timken has done, all angles must be thoroughly checked before any attempt is made to operate this type of equipment.

The operation of an efficient production control system depends greatly on the ability to quickly identify material in process. As Timken already identified material by the bundle, this was no problem. In plants where material identity depends on heat numbers to identify units of 200 or more tons, this can be a problem. In gondolas, a heat can be identified in four units. By straddle truck, twenty units must be identified.

Outdoor space must be considered if unnecessary handling is to be eliminated. Mills that normally keep five to fifteen thousand tons banked will require a large outdoor area. This could mean that a man must be added to supervise the movement of material in and out of this area. However, if adequate space is available, the elimination of rehandling will more than justify this cost.

In most cases the advent of the straddle truck will mean a revamping or expansion of maintenance facilities. A reasonable supply of spare parts must be kept on hand and a good preventitive maintenance set-up must be installed to insure high operating efficiency. This expenditure will be more than offset by low operating costs.

None of this is in condemnation of straddle trucks. We operate them in our plant and have found their existence is justified through the elimination of switching costs alone. Additional savings are realized through the elimination of rehandling material and hazardous work of loading and unloading gondolas.

Having seen Mr. Wier's maintenance set-up, his shops and facilities, I am asking him to explain what he calls "package replacement." I am sure it can be used by all of us not only in straddle trucks but all materials handling equipment from hand trucks to locomotives.

Frank C. Wier: Replacement of parts are usually on a "unit" or "package" basis—that is we try to avoid tinkering with minor parts. If, for example, rings in an engine need to be replaced, the whole engine will usually be replaced. This procedure would also apply to units like clutches, transmissions, differentials, etc.

The whole unit is replaced and the defective or worn unit is rebuilt by our mechanics as they have time to do so. This procedure of rebuilding units, insures a steady work load for the entire mechanical force and keeps our equipment running at a high percentage rate.

John W. Kight: I have observed that it is frequently difficult to get people to read correctly. It is even more difficult to get people to hear correctly. I wonder how you have any assurance that the operators of these trucks will pick up the right load.

Frank C. Wier: I should like to approach your question by a devious route. In using such a radio system all operators hear everything that is said to anyone. When we first approached the project, we were somewhat doubtful about this phase. We did not like it. It has worked out to be the opposite. I cannot tell you the mental reactions of these people, but they are not disturbed in any manner by hearing everything that everyone is told. I do not know of many cases where we have had much difficulty in getting the proper interpretation of orders. The men like this system. There has been no opposition. They take to it, and I think that that might have a bearing on their willingness to learn to listen.

They also had to learn to talk correctly, and it took a little training.

An Evaluation of Oil Purifiers FOR STEEL MILL SERVICE

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Newark, Delaware

. . . . operating results obtained from an oil purification system depend on proper selection and installation, followed up by adequate maintenance and inspection . . .

▲ THE search for increased output and lower production cost in all branches of industry has been intensified by the pressure of ascending wage scales and shorter working hours of the past few years. This is particularly true in the steel industry today. Not so many years ago it did not make too much difference if production was momentarily interrupted. Equipment operated at slow speeds and continuity of production was not so important. Production loss could be made up by running a few extra hours. Today, however, things are very different. Production schedules are rigid with virtually no time allowed for contingencies. Equipment is designed to operate with minimum down-time and when production is lost it is difficult to make it up. Outputs that dwarf production figures of a few years ago are no longer a plant "luxury" for the production department. They are today a necessity. This increased production demand has brought about rolling speeds that are double and in some instances triple of those fifteen or twenty years ago. With increased speeds has come higher pressures and a demand for greater uniformity and precision.

This increased demand has been successfully met only by giving careful attention to many design and operating factors formerly neglected or not considered important. Not the least of these is that of lubrication. Today, more than ever, operators depend upon lubrication in all of its ramifications to keep equipment operating at full capacity. The progressive steel mill manager is vitally interested in lubrication from two standpoints: first, as an essential factor to uninterrupted production; and, second, as an element of cost, which in these days of keen competition is not to be taken lightly.

FIELDS OF LUBRICATION

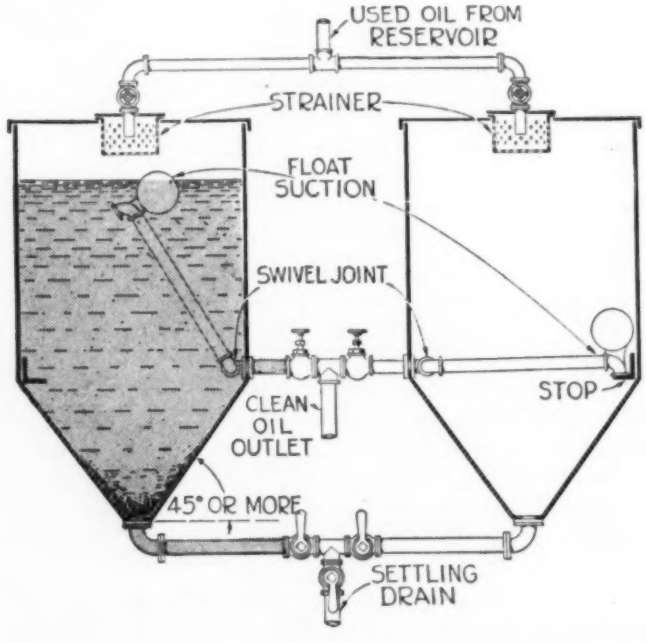
The subject of lubrication naturally divided itself into four broad phases, each of which is essential and cannot be slighted if maximum production is to be realized at minimum cost:

1. Equipment must be *designed* for correct lubrication and for the proper application of lubricants.
2. Correct lubricants must be *purchased* and adequate supplies maintained where needed.
3. The correct lubricant must be *delivered* at the time when needed and in the right quantity to the particular spot at each machine throughout the plant.
4. After being put into use, the lubricant must be given the *proper care* while in service.

It is this last but not least important phase of lubrication that is discussed in this paper. It is my considered opinion that this phase of lubrication is the most neglected of any of the four listed.

Nowadays considerable care is taken when designing equipment to make certain that adequate and proper seals, oil ducts, and grooves, supply and drain lines are provided. Experts are consulted to insure that the best lubricant is purchased for the job at hand.

Figure 1 — This batch-acetylene tank is self-cleaning, and the conical bottom is the essential factor in making the tank self-cleaning.



Also detailed lubrication schedules are planned and organized for each piece of equipment in the plant and efficient storage facilities and dispensing equipment are provided. But all too often, the operator stops here and does not provide plans, schedules or equipment for taking proper care of the oil while in service.

If lubricating oils were perfect, there would be no need for concern with this phase of lubrication, as the perfect oil would retain its original physical and chemical properties forever, regardless of the design of the system, operating practices, and mechanical conditions of the system.

OIL DETERIORATION

The stability of lubricating oils and the design of oiling systems have been greatly improved during the last decade. Nevertheless, oils, regardless of the crude from which they are made, the method of refining employed, the regimentation agents added, and the provisions provided in the design of the system to exclude extraneous contaminants, still undergo in service physical and various complex chemical changes. Some oils, of course, change in service at a greater rate and to a greater degree than do others, and some systems are more effective than others in excluding foreign materials from the oil. The changes that occur in oils while in service are caused chiefly by oxidation, and to somewhat lesser extent by thermal decomposition, polymerization and condensation.

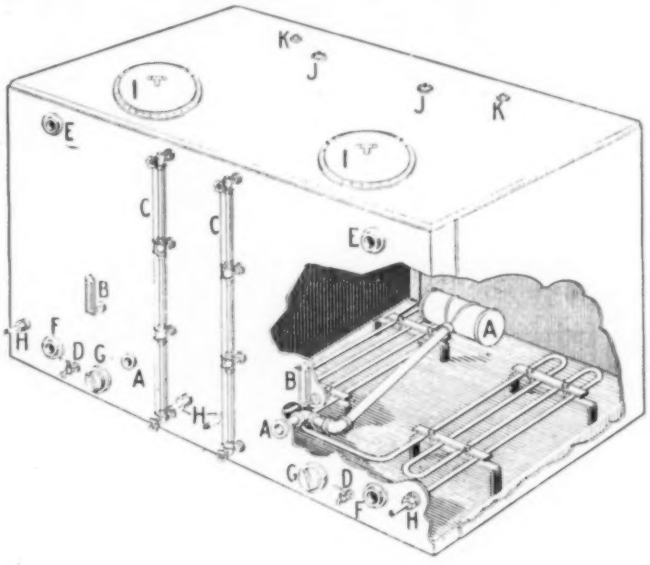


Figure 2 — A two compartment batch-settling tank.

In shape an oil molecule can be visualized as something between a turtle and a rattlesnake. It has a nucleus of carbon atoms arranged in one or more rings to which are attached chains of carbon atoms of varying number and length, to which hydrogen atoms are connected in numerous ways.

Oil deterioration is a relatively complex phenomenon, the kinetics of which are far from being understood. At various times and stages of oxidation there may be found in oil organic acids consisting of volatile acids

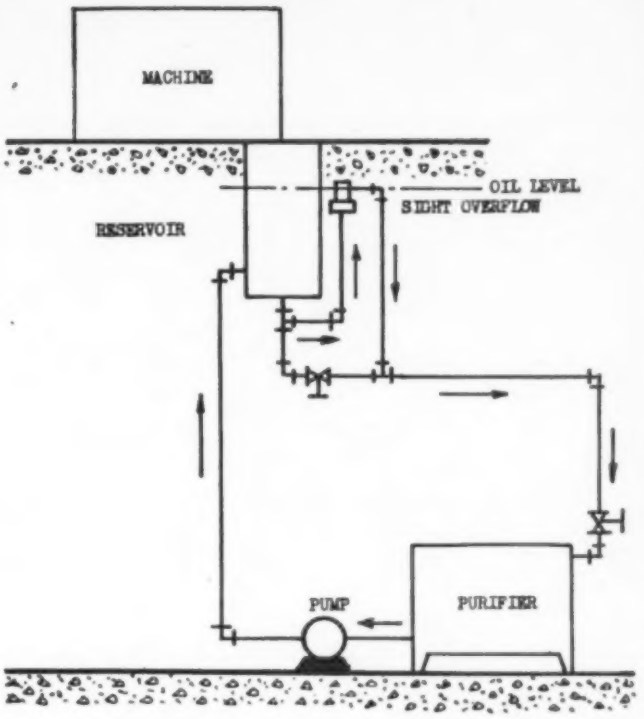


Figure 3 — Elements of a simple continuous by-pass purification system.

(formic, accetic, propionic, butyric, etc.) and fixed acids (phenols, hydroxy and dicarboxylic acids, lactones, etc.), volatile carbonyl compounds (aldehydes and ketones), and saponifiable materials (esters, anhydrides, and possibly lactones, phenols, etc.).

In addition to these complex oxygenated products, similar complex compounds are often simultaneously produced by thermal decomposition, polymerization and condensation. All of these chemical changes are, of course, greatly aided and abetted by the presence of external contaminants, such as metallic particles, rust, atmospheric dust, water, cooling system chemicals, etc.

Collectively these products, including foreign matter, are commonly referred to as sludge, the character of which varies widely depending on the properties of the original oil, operating and mechanical conditions of the equipment, and the nature and amount of foreign impurities present. Sludge varies from liquids to solids. It is an intimate mixture of emulsified material, precipitated asphaltic and resinous substance, solid impurities, metallic soaps, and usually some good oil. In some cases, it is a shiny black, or reddish brown liver-like mass; in others, it is a dry, coke-like, gritty material. It may be oil soluble or oil insoluble. The oil-soluble type, remains liquid in the oil at the operating temperature, but most of it becomes insoluble and precipitates when cooled. It is, therefore, carried in suspension by the oil until it comes in contact with the cooler parts of the system, where it tends to settle out.

Generally, some of the insoluble sludge is also carried in suspension by the oil due to its motion, but it tends to settle out in the pipes, passages, reservoirs, and other places where the flow is slow.

As a rule, sludge forms slowly; but sometimes, because of a rapid temperature rise (the rate of oil oxidation doubles for each 15-or-20-degree temperature rise),

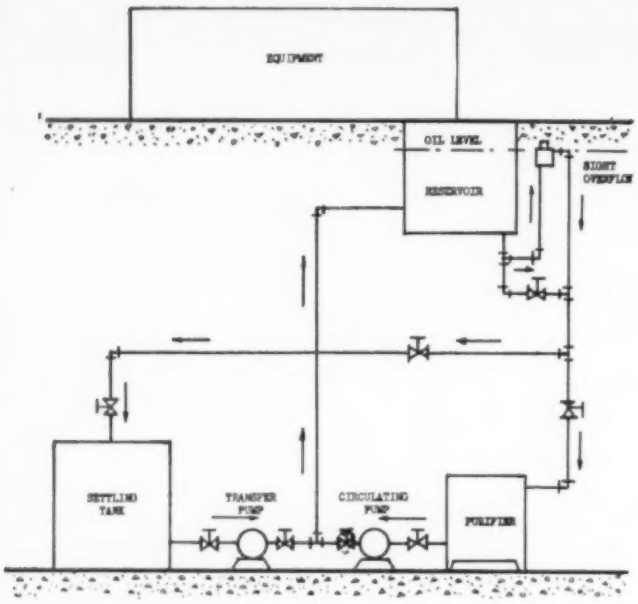
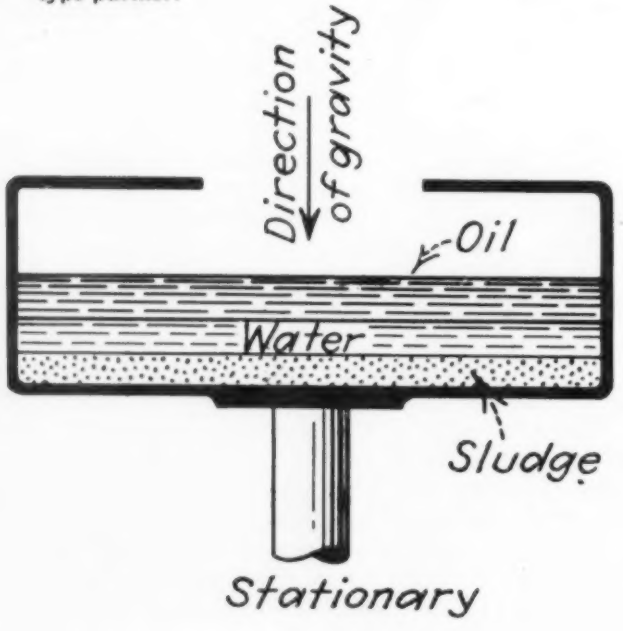


Figure 4 — A simple continuous by-pass batch purification system.

a sudden and unexpected accumulation of water or other substances, it may form quickly.

If impurities are permitted to collect, the oil becomes unfit for further use. This is not due to the oil wearing out or losing its lubrication value, as many believe, but to the fact it becomes contaminated with detrimental impurities, which are likely to clog oil ducts, holes, passages and pipes. Many solid impurities are of an abrasive nature and cause excessive wear. Sludge is usually of an acid nature and, if allowed to collect for any appreciable period, may cause corrosion, especially to highly polished surfaces. Moreover, sludge tends to cause an increase in operating temperatures and sluggish operation of equipment. It also acts as a catalyst to accelerate the formation of more sludge. In other words sludge begets sludge.

Figure 5 — The sketch shows the principle of the gravity type purifier.



Removal of sludge from oil is, therefore, most essential if lubricating difficulties are to be avoided. It has been proved that if impurities are removed constantly or at frequent intervals the life of the oil is practically indefinite.

PURIFICATION METHODS

From this brief discussion of oil deterioration, it is evident that highly beneficial results can be achieved by the use of a properly designed, installed and operated system of purification that will minimize the accumulation of sludge in a circulating oiling system.

No single method or system of purification is best

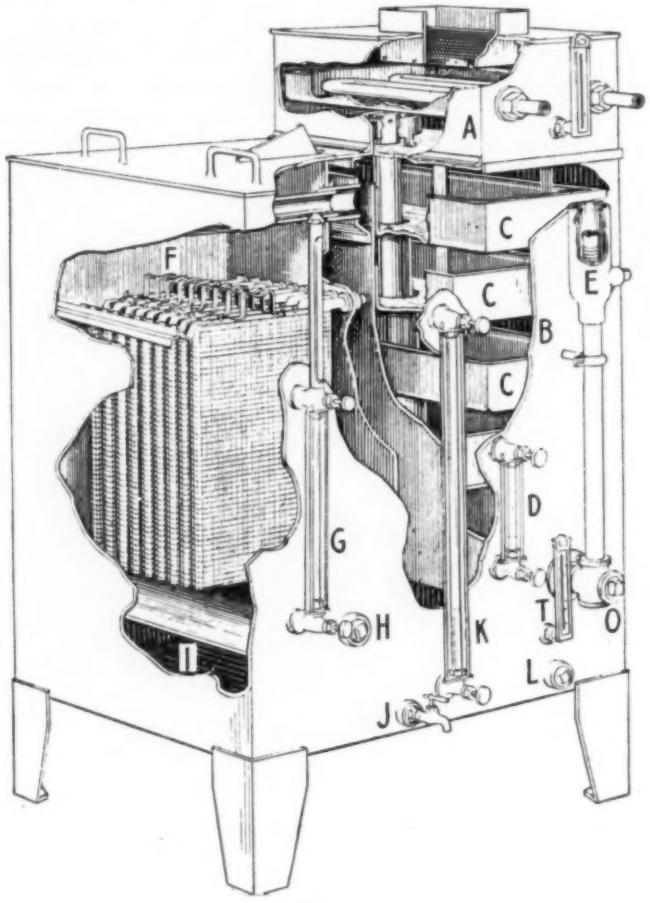


Figure 6 — The small gravity type purifier illustrated is suitable for some steel mill services.

suited for all operating conditions and equipment. Purification systems must be matched to the nature of the impurities involved and the operating conditions of the equipment. Methods of purification, however, may be divided roughly into three principal groups: (1) batch, (2) continuous, and (3) combination batch and continuous.

Batch purification provides for withdrawing the entire volume of oil, preferably while still hot, and running it into a settling tank where it is permitted to remain quiet for ten days or longer. During this time, water and insoluble impurities settle to the bottom of the tank and much of the sludge, soluble in the oil at

the operating temperature, becomes insoluble and also settles out. Batch settling is the only method, generally accepted at present, for reducing appreciably the soluble sludge content of oils.

For the purpose of increasing the rate of settling, settling tanks are often provided with steam or electric heating coils. Where time permits, however, more thorough clarification is obtained without the use of heating coils. Moreover, due to convection currents, practically no settling will occur while the oil is being heated. Obviously, the clarified oil should be withdrawn with care from the settling tank to prevent remixing the settlings and oil. This can be done best by providing a float suction.

Disadvantages of this method are: (1) Two complete batches of oil are generally required. (2) It is generally necessary to shut down the equipment to change the oil. (3) Considerable space is required for settling tanks. (4) At least ten days are required for thorough clarification. (5) Impurities are not removed as they collect but build up to some predetermined concentration, at which time the batch is withdrawn and purified. Obviously, for a considerable period the oil may be heavily loaded with impurities and is practically never clean. Under certain conditions, disadvantages (2), (3), and (4) are of little or no importance. For example, in many instances the schedule of oil purification can be arranged to coincide with scheduled shutdowns for cleaning and overhauling.

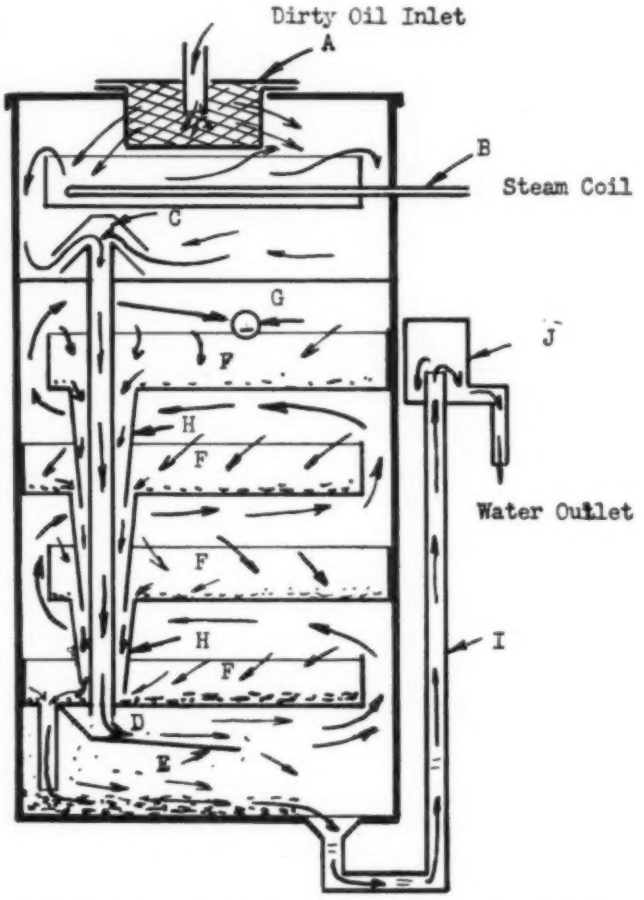


Figure 7 — Schematic diagram of precipitation compartment of gravity-type purifier.

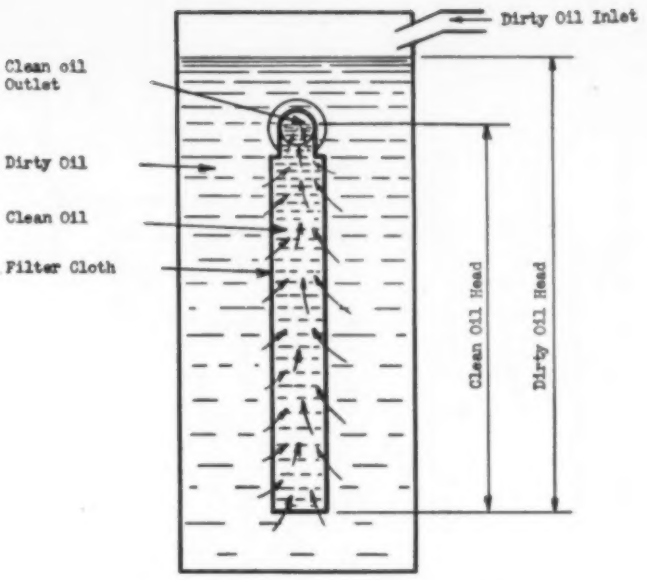
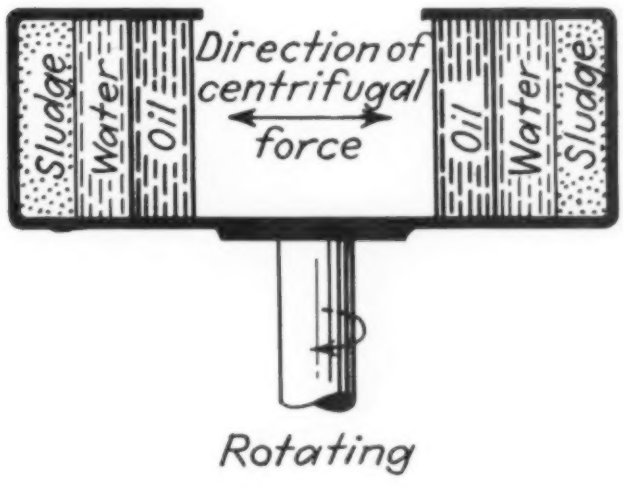


Figure 8 — Section through submerged plate type filter unit.

In general, equipment required for batch purification is relatively inexpensive and simple. The purifier itself is generally easily made and may be only an old discarded steel drum or wooden barrel. It is recommended, however, where any considerable quantity of oil is to be purified, that a special tank or tanks be provided. It will be found generally advisable to provide two tanks; furthermore, wherever headroom is available, conical bottoms are recommended. This type of bottom, is sloped 45 degrees or more, makes the tank practically self-cleaning. Shown in Figures 1 and 2 are two designs of batch settling tanks.

Continuous purification provides for continuous cleaning of all or any part of the oil in each cycle as it is circulated through the system. When only a part of the oil flows through the purifier in each cycle, it is commonly called a by-pass purification system, as shown in Figure 3. A continuous purifier may be simply a fine-mesh metal screen or strainer or a cloth strainer, or it may be any one of several designs of gravity and pres-

Figure 9 — The principle of the centrifugal purifier is shown schematically by this sketch.



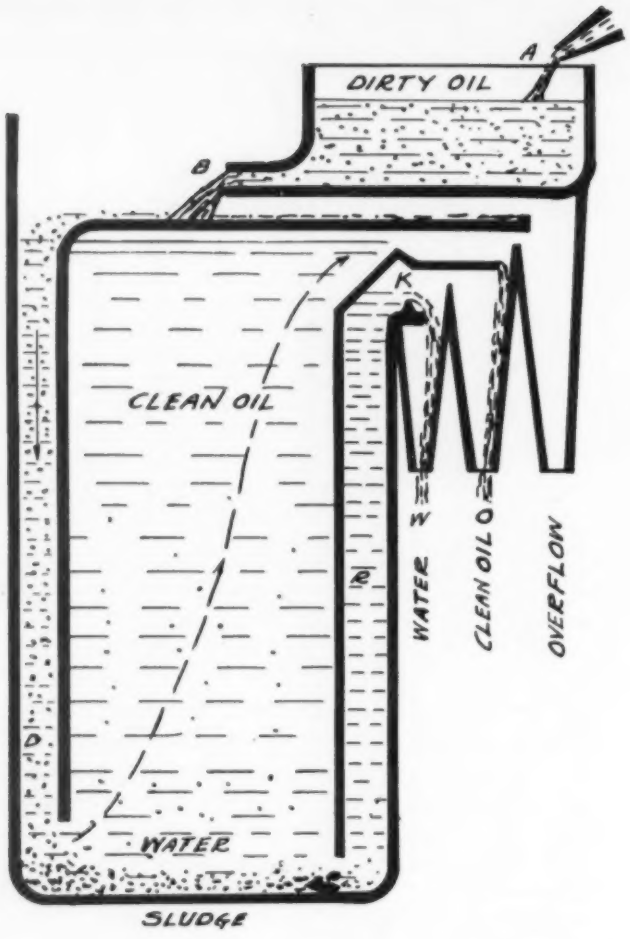


Figure 10 — Stationary gravity purification tank.

sure-type filter, or of various types and designs of centrifuge. All of these will be discussed.

Screening is the simplest and one of the most commonly used methods of continuous purification. It is frequently used in combination with other devices and methods to relieve other parts of the purifying system of wear and tear. Its use is limited to removing the coarse contaminants, such as metal chips and particles or grit and scale. Soluble sludge, acid constituents, water, and the finer insoluble-sludge particles, and atmospheric dust cannot be removed by screening.

The continuous method of purification, where all oil flows through the purifier, has the disadvantages that the equipment required, in most instances, is large; its initial cost is often out of proportion to the savings; and only a relatively small proportion of the soluble products of oxidation is effectively removed. Comparatively recently, however, small high capacity by-pass filters have been designed that largely overcome the first two disadvantages.

In the by-pass system of continuous purification, oil is taken from the reservoir bottom, where water, sludge, and other impurities collect, and a portion of it is passed through the purifier, the remainder being circulated as usual. The purified oil is returned directly to the main reservoir.

In this method, usually from ten to twenty-five per cent of the oil per cycle is circulated through the purifier, hence, the equipment is smaller and costs less than when all oil is passed through. The degree of purification of the oil is much less, however, than when all oil is passed through the purifier each cycle. In either case, soluble products of oxidation, etc., are not effectively removed, so that their concentration gradually increases. This concentration eventually becomes so high that the oil must be changed or else batch-treated to remove them.

Combination batch and continuous purification in most instances (Figure 4) is a combination of the batch and the by-pass methods. The by-pass part of the treatment partially removes water and other insoluble impurities while the oil is in service. This retards the rate of oxidation and guards against formation of severe sludge formations. The batch treatment periodically removes all insoluble impurities and reduces soluble impurities to a point at which they are no longer a detriment.

OIL PURIFIERS

The heart of any purification system is the purifier itself. For the purpose of discussion these may be divided into three classes:

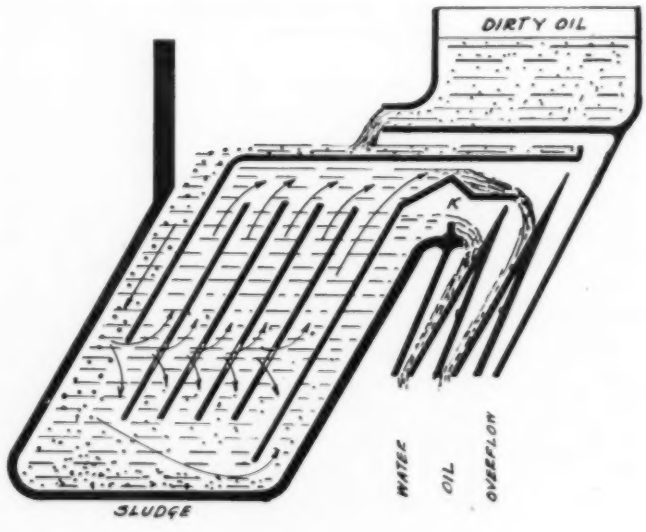
1. Gravity type.
2. Centrifugal type.
3. Pressure type.

Shown in Figure 5 is the basic principle upon which the gravity-type purifier operates. These purifiers remove impurities from lubricating oil by screening, precipitation, filtration, and in some designs by washing with water. In general, provisions for performing these processes are incorporated in a single unit.

Screening consists of passing contaminated oil through a fine-mesh metal screen, perforated metal plate, or various porous materials. Screening, invariably the first process, removes any coarse, solid impurities that may have entered the oil, thus relieving the precipitation chamber and filtering elements of doing this job.

The precipitation or settling process employs gravity

Figure 11 — The baffles in this skewed stationary gravity type tank help to direct the flow of oil into thin channels.



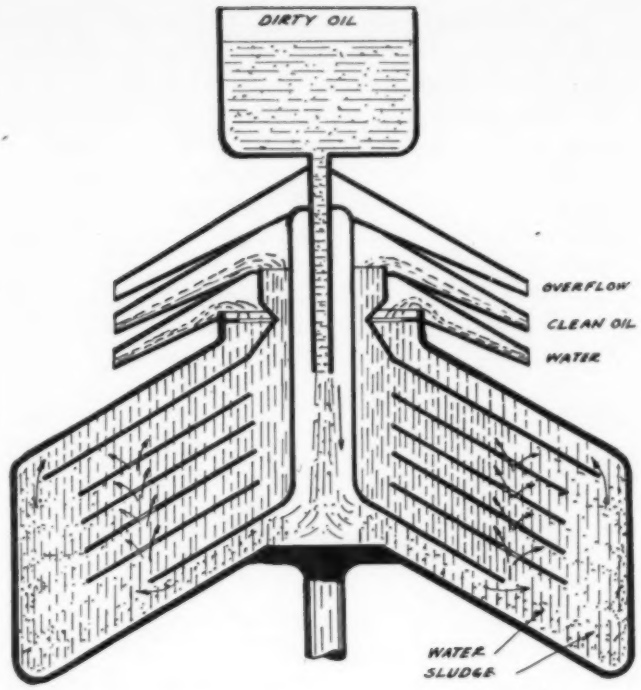


Figure 12 — Section through rotating centrifuge type purifier.

to separate impurities from the oil. Most impurities, including water, are heavier than clean oil and settle out readily. Others, however, have the same or practically the same specific gravity as oil and cannot be removed by precipitation. The more nearly equal the specific gravities of oil and its impurities are and the more viscous the oil, the greater the time required for separation.

Fortunately, heating reduces both the specific gravity and viscosity of oils, and so oil is often heated by steam coils or electric heaters to decrease time required for precipitating impurities. However, more thorough clarification can be had by not heating, provided that sufficient time can be given to the process. This is because sludge that is insoluble and would precipitate at the lower temperatures becomes soluble at higher temperatures and will not settle out. Quicker settling is effected by causing the oil to flow through the precipitation chamber in shallow or thin layers. This is generally accomplished in the purifier by the use of baffles or trays, which divide the mass of flowing oil into relatively shallow layers.

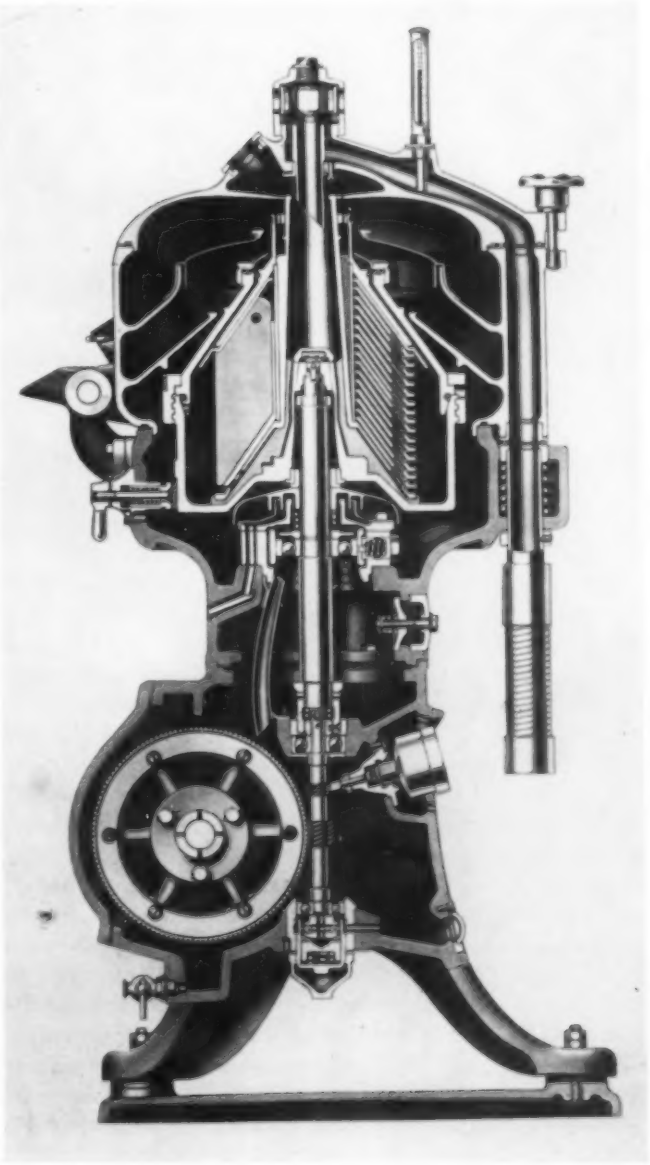
All impurities cannot be removed by screening and precipitation, and so some other method must be incorporated within the purifier to complete the cleaning. Basically, this is generally done by screening, using filter media such as cotton waste, wood wool, felt, excelsior, fuller's earth, or some other porous material.

It is generally desirable to have the filtering element arranged in several units, so that any unit can be removed for cleaning or be quickly replaced by a clean one without interfering with filtering. When oil contains very fine particles, a large filtering area and a slow rate of flow through the element are required if satisfactory clarification is to be secured. Even with a finely woven cloth-filtering element, and a slow rate of oil flow, soluble sludge is not removed to any appreciable extent. It is therefore desirable to pass the oil through slowly and at low temperature so that the maximum amount of so-called soluble sludge will be removed.

In Figure 6 is shown one design of a small, gravity-type purifier suitable for some steel mill services. This unit is designed for continuous operation and is provided with an automatic water ejector. The oil enters through the removable coarse screen at the top and then passes over the steam coils, which may or may not be used. It then passes down to the bottom of the separating compartment, which consists of a number of trays set in staggered positions to permit the oil to flow back and forth as it rises to the top and overflows into the filter compartment where it passes through the plate-type filter units and, after filling up this compartment to a predetermined level above the clean oil outlet, it runs into the clean oil compartment.

The action that occurs in the precipitation compartment may be better understood by referring to Figure 7. The contaminated oil enters through screen *A* and after passing over heating coil *B* flows into vertical tube at *C* and out at *D*. When the oil discharges from

Figure 13 — A section through one design of a commercial centrifuge.



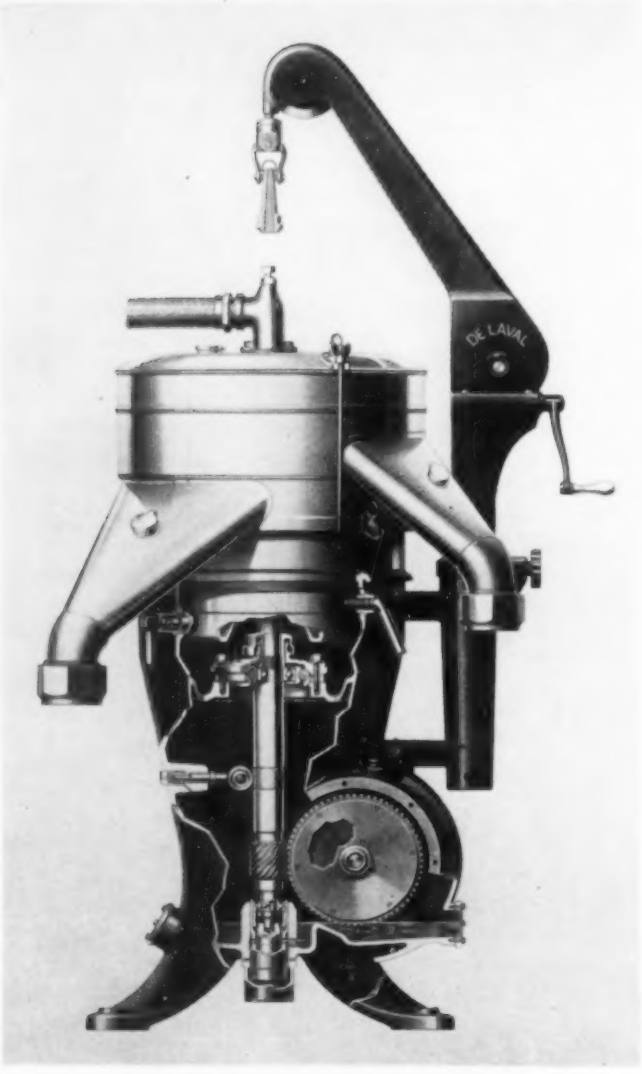


Figure 14 — Another design of a commercial centrifuge.

the lower end of this tube, it is spread by plate *E* in a fan shaped layer and takes a zigzag course upward, over and under trays *F* and out into the filter compartment at *G*.

The function of trays *F* is to divide the stream of oil into relatively thin layers and reduce its flow to a very low rate (less than nine in. per minute) so as to provide time for impurities to settle out. Solid impurities collect in the trays and are periodically removed. If water is present, it also settles out in the trays but, being a liquid and heavier than oil, drops through the conical shaped tubes *H* to the bottom of the compartment. It is removed automatically from the compartment through channel *I*, which in effect is the short leg of a U-tube. On the long-leg side we have the compartment itself filled with a mixture of oil and water and on the short-leg side we have channel *I* filled entirely with water. It is obvious that the hydrostatic pressure at any given elevation in the compartment and channel *I* will be equal when there is no flow. As the concentration of water in the oil in the compartment increases as dirty oil enters, the pressure increases in the compartment over that in channel *I*, thereby causing water to run automatically out of overflow *J* to waste.

As previously stated, the partially clarified oil flows from the precipitation compartment through the overflow into the filter compartment, containing several filter units, the number of which depends on capacity and flow rate desired. These units have a frame made of U-shaped channel with removable top to which is attached the discharge spout. This frame is covered on all sides with coarse mesh wire screen internally reinforced. A cloth filter bag is put over this assembly, tucked in at the top, and the removable top containing the discharged spout is then attached.

In Figure 8 is shown a sectional elevation of one of these filter units or bags. When the purifier is in operation, the unit is completely submerged in dirty oil. No flow takes place until a head of dirty oil builds up over the clean oil outlet. Thus we have in effect here, as in the precipitation chamber, a U-tube with unequal legs of which the dirty oil in the filter compartment is the long-leg and the clean oil inside the filter unit the short one. As a cake or layer of impurities builds up on the face of the cloth, the "dirty oil leg" increases in height in order to overcome the increased resistance to the flow of oil through the cloth, advantage is taken of this increased resistance to provide a tell-tale for indicating when the bags need changing by attaching to the front of the filter a gage graduated in inches.

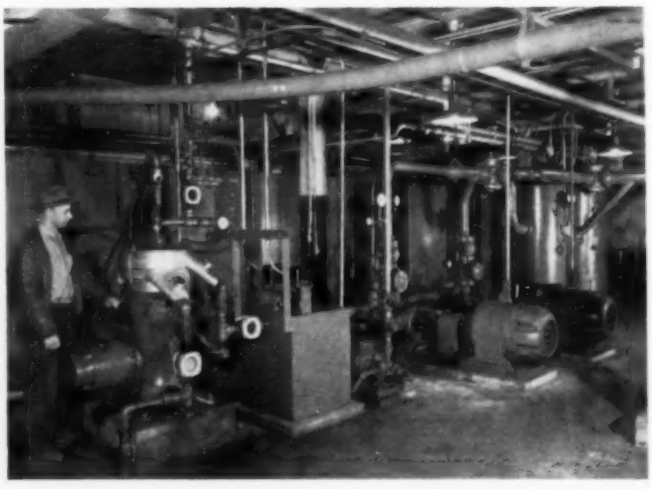
This type of purifier is commercially available in several different designs and sizes for various operating conditions and fields of service.

The basic principle of the centrifugal purifier is the same as that of the gravity purifier except that centrifugal force produced by rotation is used to effect separation of the impurities from the oil in place of the force of gravity. This basic principle is shown in Figure 9.

The basic similarity between the centrifugal and gravity purifiers is made clearer by reference to Figures 10, 11, and 12.

Figure 10 shows diagrammatically a stationary gravity purification tank. Dirty oil from the lubricating system flows into the tank from *A* through outlet *B* across plate *C* down channel *D* to the bottom of the tank where solid impurities, water and insoluble sludge settle out. The oil flows diagonally upward through the tank

Figure 15 — The steel plant purification system illustrated has a centrifuge as one of its components.



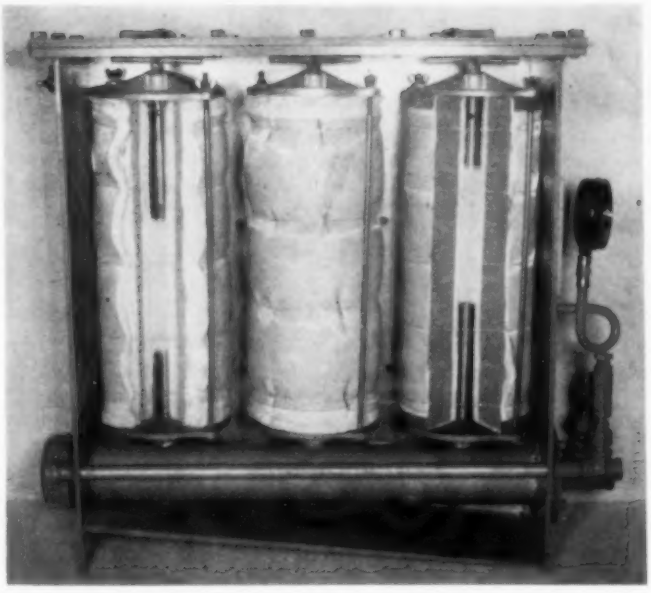


Figure 16 — The pressure type purifier shown has a combination cartridge of wood fibre cellulose and Fuller's earth.

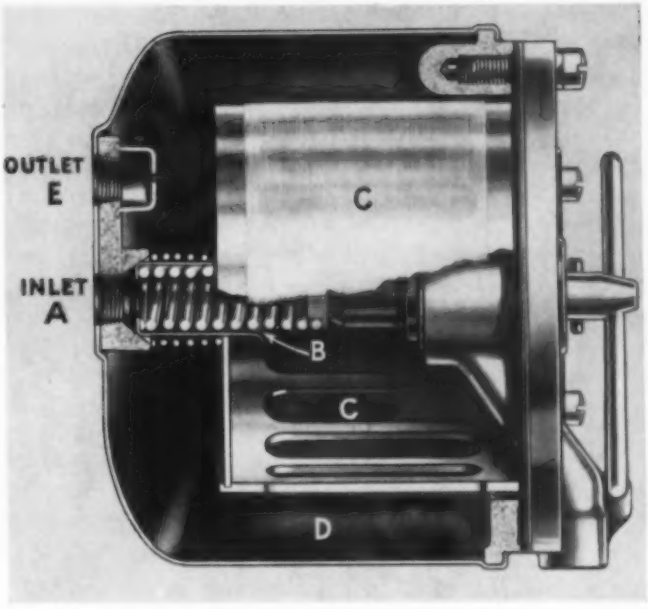


Figure 17 — This pressure type purifier has a metal element.

and out spout *O*. Simultaneously, the water rises, for reasons previously explained, in channel *R* and overflows weir *K* and out spout *W*.

Figure 11 shows a tank similar to that shown in Figure 10, except it contains baffles and is skewed out of square. The baffles serve to brake the flow of oil into relatively thin channels, thereby increasing the capacity of the unit. It operates in exactly the same manner as the tank shown in Figure 10.

In Figure 12 is shown the conversion from gravity-type tank to the rotating bowl of the centrifugal-type purifier. It is obvious from these illustrations that the basic principle of the gravity and centrifugal purifiers is the same.

A commercial design of a centrifuge is shown in Figures 13 and 14. Many different designs of centrifuges are commercially available in a wide choice of sizes and types to meet service requirement. They, like the gravity type filter, may be used either for continuous or intermittent operation. Also, they may be arranged for "full flow" or "by-pass" filtration. Figure 15 shows the installation of a centrifuge in a steel mill.

Pressure filters have come into quite common use with the development of the force-feed circulating systems. Basically, there is little difference between the gravity purifier and the pressure filter, except as to the pressure that causes the oil to flow through the filter. We restrict the word "gravity" to describe a filter which depends upon the difference in head between two columns of oil—one clean and the other dirty—to force the oil through the filter medium. On the other hand, we use the word "pressure" to describe a filter that employs a mechanical pump to force the oil through the filter. Obviously, a gravity-type filter is, therefore, a very low pressure filter.

There is also an important difference in the application of these filters. Whereas the gravity (or centrifuge) type of filter is commonly used either intermittently or continuously, the pressure filter is rarely used for intermittent filtration.

Pressure filters are available in a great variety of designs, sizes, shapes, and filter media. One design having replaceable combination refills consisting of woodfibre cellulose and bauxite is shown in Figure 16. The cellulose portion of the refill removes the larger solid impurities and absorbs water, if present. The bauxite does a so-called "polishing" job by removing fine abrasives and sludge. In general this type of purifier is used in a continuous by-pass type of purification system.

In Figure 17 is shown one design of a metal element type, pressure filter. In this filter the dirty oil enters inlet *A*, flows up through the center tube and out at *B*. It then flows through chamber *C*, through the closely spaced wires to outer chamber *D* from which it flows to outlet *E* containing an orifice. The purpose of the orifice is to control the rate of flow through the filter, which is done by using different sized orifices.

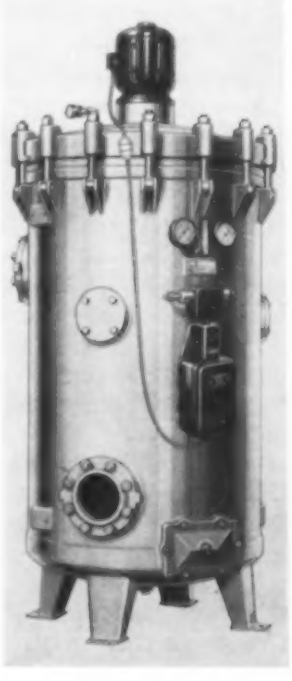


Figure 18 — Automatic pressure type purifier.

Shown in Figure 18 is an automatic type of pressure filter suitable for many steel mill services. This filter is designed for continuous service where the oil contains large quantities of impurities. This is also a metal element type of filter, having from two to six elements made of stainless steel. The design is such that the cakes or layers of dirt that build up on the elements are continuously removed by motor driven scrapers. Elements of different porosities are available to meet various service conditions.

CONCLUSION

In conclusion it should be pointed out that oil purification starts with taking all practicable precautions to prevent the ingress of extraneous impurities into the lubricating oil system. Prevention is always better than a cure.

The results realized from a purification system will depend in no small degree upon the installation of the system and the attention given to it while in service. The installation should be rugged, easily accessible for maintenance and inspection.

Obviously, a purification system should not be installed where no return on the investment will be realized. At the September, 1939, Convention of the Association of Iron and Steel Engineers, Mr. R. M. Gordon said in discussing the paper "Modern Lubrication of Existing Equipment" by Mr. F. J. Thomas that a mill superintendent had said to him that eighty per cent of mechanical failures in his plant was due to faulty lubrication. Whether or not you agree with the eighty per cent figure, it must be admitted that a relatively high percentage of our troubles in steel mill operations are traceable, directly, or indirectly, to faulty lubrication of which taking care of the oil while in service is an important part.

DISCUSSION

PRESENTED BY

F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

W. H. CRAIG, District Manager, The Sharples Corp., Cleveland, Ohio

KARL ARNOLD, National Tube Co., Ellwood City, Pa.

DON E. WHITEHEAD, Lubrication Engineer, Crucible Steel Co., Pittsburgh, Pa.

C. S. BULLIONS, Lubrication Engineer, Socony Vacuum Oil Co., McKees Rocks, Pa.

W. F. WHITE, Weirton Steel Co., Weirton, W. Va.

R. A. KRAUS, General Mechanical Foreman, Republic Steel Corp., Chicago, Ill.

JAMES I. CLOWER, Chairman, Department of Mechanical Engineering, University of Delaware, Newark, Del.

F. C. Schoen: It was mentioned in the conclusions that an oil purification system should not be installed where no return on the investment will be realized, obviously this statement is true and without such justification we would have difficulty in obtaining funds to make installations. The big difficulty here, as we see it, is how to determine possible savings, in the cases, for example where we have equipment in service, designed prior to the time that special oils, pressures and high volumes were required, when such equipment is giving good performance without excessive maintenance and delay charges. We realize certainly that clean oil will increase the life of all points that it serves, and it is our desire to maintain our oil in the best possible condition, but too often (in our opinion) we have had to pass up installation of equipment becauses guesses as to increased life of parts and decreased delay charges are poor data to use in requesting expenditures for equipment.

The paper also briefly touched on the use of pressure filters installed as part of force feed lubricating systems. Here, especially on smaller systems, we find the filter installed between the reservoir and the points to be lubricated. I would like to ask whether such an arrangement has any advantage other than possible cost savings over the normal filtering which is performed before oil returns to clean oil reservoirs.

I might add that purification equipment has become more important on older equipment, due to the various river cleanup programs, with the necessity of drying up leakage.

W. H. Craig: Professor Clower presented a very interesting and timely paper, because there is a real lack of comparative information on various types of purifiers. I believe that we can all understand from his paper that there are three systems of purification: gravity settling, centrifuging, and filtration (including straining, pressure filters, and gravity filters). Each has its own place depending upon the quality of the oil, the degree and nature of the impurities, the service conditions, and the economics or the costs surrounding the particular installation.

There is one question that comes to mind. In regard to the additives used with oils today, we understand that most of them are used to inhibit oxidation, to improve the film strength, and to increase the wetting action of the oil. We all have heard of additive type turbine oils which have been used for many many years. These oils are said to be in as good condition after this service as when they were originally put in the turbines. Much of the long life of these lubricating oils has been attributed to the function of the additive in inhibiting oxidation. The natural thought, I think, that occurs to most of us is that if a little additive in the oil is good under certain service conditions, why would not more be better? I put that question to one leading oil chemist, and he replied that these oils are designed with the proper type and amount of additive for a specific job. In other words, the efficiency of the additive to perform its function follows a curve, with peak results only at one point or per cent concentration in the oil. Too much additive drops the performance curve right down again. Too little additive can have the same effect, and we all know that some additives or inhibitors can be removed from the oil by certain treatment.

Now, I wonder if Professor Clower would mind giving his opinion on each of the methods of purification which he has discussed in regard to handling additive oils, especially in regard to the effect on the additives themselves?

Karl Arnold: Oil purification, as I see it, is a matter largely justified by the economics of the lubrication set-up where sufficient quantities of oil are involved; for example, it is justifiable to purify turbine oil, and by the same token, it is not justifiable to purify oil which is used "once through" on loose bearings which use a cheap oil.

The principal reason for oil purification is to restore the used oil to its original properties by the removal of water, dirt, diluents and harmful acids. This arises from the fact that the lubricating value of oil is controlled not by age of the oil or its use, but by the introduction of these various contaminants plus heat and oxygen; these contaminants in combination with air and heat form the harmful sludges which reduce the lubricating value of the oil. Irregardless of the method of purification employed, there comes an end point, due to the inherent deficiencies of any method of purification when the oil must be renewed because the old oil will have lost its reasonable similarity of properties of new oil. Since the rate of contamination is relatively slow at first and then increases rapidly with time, the change-over date will depend upon the type of purification employed and its efficiency in purifying the oil.

The type of unit to be employed in purification depends upon the type of equipment being lubricated, for example on installations where there is no possibility for contamination by diluents, the use of mechanical filters such as screens with periodic centrifuging would be sufficient to purify the oil. Thus the total money saving results from purification require a careful analysis of the lubrication set-up which includes costs of changing oil, cost of new oil, and cost of the oil purification itself.

Mechanical filtration by means of screens, waste packed filters, etc., is effectively used to remove dirt particles, metallic chips, etc. Screens are most effective, especially when used to filter large quantities of oil, when arranged in a series of coarse, medium and fine screens, this arrangement prevents overworking of a single screen and each size screen will effectively catch particles without seriously impairing the flow of oil in the system. The portable centrifuge is probably one of the best all-around methods of oil purification for a steel mill. This outfit will remove water, solids, and if it will heat the oil hot enough, will remove some volatile acids. The use of the centrifuge requires periodic checking of the oil and periodic processing. Its main disadvantage is that it will not remove soluble sludges; such sludge being soluble at high temperature and insoluble at low temperature. Its inability to remove all acids is not a serious drawback since some acids, especially the high molecular weight carboxylic acids are non-corrosive and actually inhibit corrosion.

A great deal has been written concerning oil purification and reclamation. The problem is not effectively solved by purifying and reclaiming the oil. Much more work can be done by effectively preventing oil from becoming contaminated so as to considerably reduce the necessity of frequent periodic purifications. We know that the presence of varying amounts of water in oil acts as an accelerator in sludge formation; much of this water could be kept from getting in the oil by properly venting oil sumps and reserve tanks, thereby preventing the condensation of the water on the sides of the tanks; effective oil seals should be installed on bearing housings where water is present, steam lines used for heating the oil, or water lines for cooling should be periodically checked for leaks, and every other means necessary should be used to keep the water out. Effective screens should be installed so as to remove solid particles. Every effort should be made to prevent the oil from becoming overheated, for it is by oxidation due principally to excessive temperatures that oil starts its initial sludge formation.

Don E. Whitehead: The application of Fullers earth or equivalent material as an oil filtering media for transformer oil, oil switch oils, steam turbine oils, etc., has become quite popular; however, especially in the case of oil switch oils in which a substantial amount of solids are held in colloidal suspension in the oil, the useful life of the earth charges is quite limited. The cloth bag in which the earth is contained, or the surface of the pressed core of earth, becomes "loaded" quite rapidly to a point where oil differential pressures through the filter reach operating limits, although the bulk of the earth still exists in uncontaminated condition.

In many such applications of earth filtering, it has been found that the addition of a cotton waste or cellulose disc type filter ahead of the earth filter will substantially reduce over-all filtering cost, while permitting the advantages of earth type filtering.

C. S. Bullions: Professor Clower has very ably presented the fundamentals involved in the clarification of oils. A major problem in our Pennsylvania area is the clarification of waste waters. Observation of some equipment installed for this purpose would indicate a failure to understand the fundamentals involved. Professor Clower could do us a great favor by adding a chapter to his paper for the purpose of discussing the removal of petroleum products from large volumes of waste water at a minimum of expense.

W. F. White: I believe that we all agree that purification of oil while in service is of utmost importance in obtaining continuous and efficient production. Every oil recirculating system is different, from the standpoint of location and type of machine to which it is adapted. In some cases the elimination of dirt is of optimum importance, while in other cases the chief enemy to contend with may be water.

Regardless of the type or how efficient the purification, to maintain an oil in its original condition, constant inspection and maintenance by skilled operators is essential.

At Weirton we have in continuous operation a purification process on each of our recirculating systems. On our two tank systems we have what Mr. Clower defined as combination batch and continuous purification, both of which have proven very satisfactory.

Centrifuges have played an important role in the purification program in our mill. With the exception of

several small recirculating systems we have centrifuges on all others. Portable centrifuges are used in our smaller closed systems when dirt or water content reaches a predetermined point.

At this time I would like to ask Mr. Clower if, to his knowledge, there is an earth type filter that will not remove the additives from an inhibited oil.

R. A. Kraus: Mr. Clower has presented an excellent resume of filteration equipment as commonly found in mill circulating systems today. As he states, the batch process or the continuous filteration cycles, of either full flow or by-pass design, are the principle methods utilized to improve oil condition. However, we have found these processes in many cases to be completely inadequate.

The development of high and particularly low molecular weight acids in circulating systems are forerunners of corrosion damage to the metallic parts of the system, and conventional settling or screening will not appreciably correct this condition. Surface active filteration aids must be employed or damage will inevitably result as the acid concentration increases. It must be remembered that the very activity demonstrated by the low molecular weight acids will tend to keep the concentration as shown by conventional test methods at a low value since these acids, after being formed, will rapidly combine with the various metal parts of the system to form metallic soaps. The filteration and removal of the metallic soap does, at least, remove the catalytic effect of these materials, but we are only removing the results of the corrosion and are not stopping the actual corrosion damage.

Vacuum dehydration units will remove these acids as well as water, and other contamination much more efficiently, but the expense of this procedure and equipment is usually not justified when chemical oxidation control methods for the oils are available. In the case of transformer oils in large installations, such as electric furnace departments or transformer stations, the improved dielectric strength of the oil treated by vacuum dehydration may warrant the expense of the installation of this equipment.

In regards to emulsion and sludge control problems, the batch process is effective for relatively clean oils, but in those cases where colloidal contaminations are encountered, the emulsions may be sufficiently tight to resist conventional settling. Similarly in modern circulating systems where gear oils are fortified by lead soap extreme pressure agents or sulphur or chlorine compounds, the stabilizing effect of these materials on any emulsion that would be formed is sufficiently strong that chemical demulsifiers in combination with heat and time must be employed. No conventional filteration unit is adequate.

In our plant there remains only one system that continues to operate on a straight mineral oil, and this condition exists only because that particular system has filtration accessories that do not lend themselves to chemical assistance in the control of the oil condition.

In conclusion, the filtration equipment on most mills today is not sufficiently efficient to handle the conditioning job expected of it, and considerable work remains to be done in developing new efficient methods. Today we are using essentially the same design filtration equipment of 30 years ago with only minor changes.

James I. Clower: In regard to Mr. White's question as to whether there is any earth filter that will not remove additives from inhibited oil, I do not know of any that will not. Fuller's earth and bauxite are the two most commonly used earths and both of them will remove all additives with which I am familiar.

Someone mentioned magnetic filters which is a type that I failed to mention in my paper. It is very widely used aboard ships in connection with the circulating oil system for geared turbines. I understand that it is very effective in removing fine metallic particles from the oil which generally act as catalyists to promote oil oxidation. It would seem to me that this type of filter might be very profitably used in some steel mill service equipment such as pinion stands.

Mr. Kraus has mentioned vacuum dehydration units. It is the only method by which it is possible to remove diluents and volatile acids. We know that the high volatile acids formed by oxidation of hydrocarbons are very corrosive. I have taken samples of various materials and immersed them in oil as well as suspended them above the oil where vapors passed over them. In all cases, those suspended above the oil showed appreciably a greater rate of corrosion than those immersed in the oil. The only practical way of removing such acids is by heating and in so doing, it is desirable that this be accomplished under a vacuum in order to prevent heating the oil to excessive temperatures.

Mr. Craig has requested my opinion of each of the methods of purification outlined in my paper in regard to additive oils. The gravity type and the centrifugal type of purifiers do not remove these additives. Some of the pressure type filters, because of the character of the filter medium, will, however, remove wholly or in part, any of the commonly used additives. As previously mentioned, the diatomaceous earth type will remove the additives. Many of these pressure filters, however, contain cotton waste, felt and other filtering materials which do not remove additives. The problems of what to do about additives has been a headache to certain filter manufacturers who are committed to the use of the earth type elements. There are many filtering mediums which do not remove additives, but they are not, in general, effective in reducing appreciably, acidity of oils. I am quite sure we do not as yet have the perfect filter medium.

In regard to Mr. Schoen's question as to how to determine the possible savings resulting from the installation of a purification system, I frankly do not know. I am quite sure, however, that any salesman of purification equipment would be only too glad to show you how this can be done. Personally, I do not hold for a minute, that purification will prove in all cases profitable. Certainly, where oils are used for only a very short period and then run to waste, purification would not pay dividends. I appreciate that in a great many cases, it is very difficult, and in some cases impossible, to show what the returns will be in dollars and cents. I do believe, however, that there are cases where such an investment would be profitable even though it cannot be proved. This, of course, makes it very difficult, and in most cases impossible, to obtain funds for the installation.

THE MECHANICAL RECTIFIER

By OTTO JENSEN
Manager Rectifier Division
I-T-E Circuit Breaker Co.
Philadelphia, Pa.

. . . . below 400 volts, the mechanical rectifier offers advantages which warrant investigation by prospective users . . . .

▲ THE mechanical rectifier was originally developed in Germany by the Siemens-Schuckert Co. After the war, an investigation by the Department of Commerce of German industry, made the German experience available to all American manufacturers, and our company decided to enter the rectifier field with the mechanical rectifier. In 1948, at the Iron and Steel Exposition in Cleveland, two mechanical rectifiers were exhibited by our company. On February 8, 1949 an installation consisting of two 3500-amp, 280-v, d-c units was placed in operation at the plant of the Buffalo Electro-Chemical Co., Buffalo, N. Y. These two units have so far operated satisfactorily and well within the prescribed specification. A second installation consisting of two 5000-amp, 100-v, d-c units has been made at the Canadian Resins & Chemicals, Ltd. plant in Shawinigan Falls, Quebec. The two installations are described in the paper.

The mechanical rectifier in many respects operates like the mercury arc rectifier, but metallic contacts, synchronously driven, are utilized for conducting instead of an electronic stream. The ohmic drop of the metallic contacts is insignificant compared with the arc drop of the mercury arc rectifier, resulting in very high efficiency, particularly in the d-c voltage range from 50 to 400 volts. The mechanical rectifier is available in six sizes from 200 to 10,000 amps in the above mentioned voltage range. It can be used whenever conversion equipment is required.

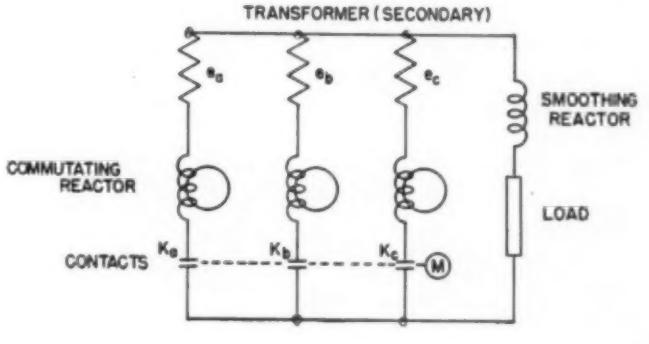
Basically the mechanical rectifier consists of a source of alternating current, a set of commutating reactors, a contact mechanism, a control circuit for the commutating reactors, known as the pre-excitation circuit, suitable a-c and d-c protective equipment and control circuits for operation of the mechanism and protective equipment, with certain interlock features to prevent faulty operation by the operating personnel.

Figure 1 shows a simple half wave mechanical rectifier. Contacts K_a, K_b and K_c are spaced 120 electrical degrees apart and are driven by synchronous motor M.

Figure 2a shows the three sinusoidal voltages delivered by the transformer. With contact K_a closed, phase a is delivering load current I_a (Figure 2b). At the intersection "A" of e_a and e_b contact K_b is closed, causing a short circuit current I_b to flow from transformer phase b to a. This short circuit current is only limited by the impedance of the circuit undergoing commutation and rises in a cosine pattern. I_b is superimposed on current I_a, which will decay in the same pattern. When I_a reaches zero at point B, contact K_a can be opened without any arc. The short circuit will then have been removed and phase b will carry the load until it becomes its turn to commutate at point C, when the process is repeated.

In order to give the contacts time to operate and to allow load variation of the machine, three commutating reactors are inserted between the transformer terminals and the contacts. The commutating reactors are supplied with magnetic cores which have a rectangular magnetization curve (Figure 3). While current I_a is decaying from load value to zero, no flux change takes place in the core, until a small negative value of current has been reached. The commutating reactors now be-

Figure 1 — Diagram of star-connected, 1/2-wave mechanical rectifier.



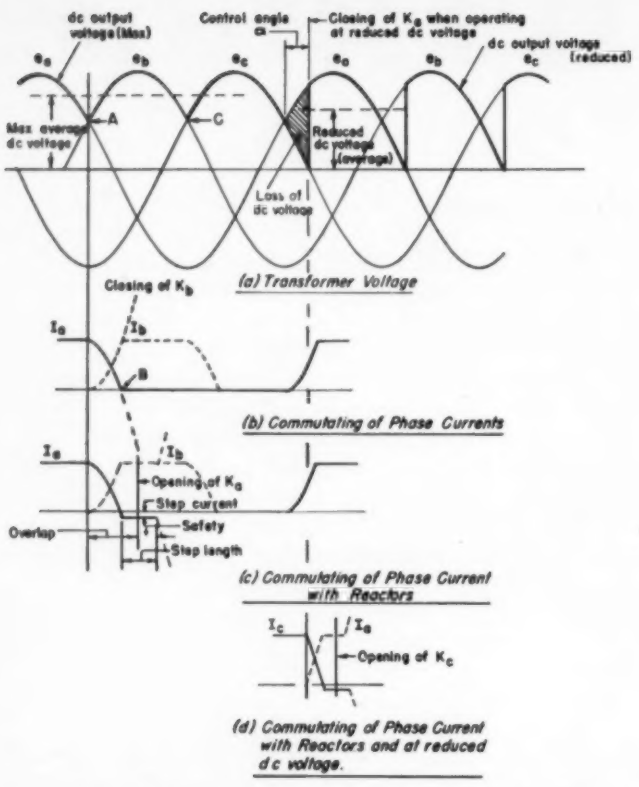

dc output voltage (Max)
Control angle
Closing of K_a when operating at reduced dc voltage
dc output voltage (reduced)
Max average dc voltage
Reduced dc voltage (average)
Loss of dc voltage
Closing of K_b
(a) Transformer Voltage
(b) Commutating of Phase Currents
Opening of K_a
Step current
Overlap
Safety
Step length
(c) Commutating of Phase Current with Reactors
Opening of K_c
(d) Commutating of Phase Current with Reactors and at reduced dc voltage.

Figure 2 — Relationship of rectifier voltage and currents.

come highly inductive and no further current change is possible before the flux has changed from positive to negative saturation. This flux change takes time and therefore a "step" of small negative current value is generated in current I_a (Figure 2c). Contact K_a can now be opened at any time during this step. However, even the small negative current which the contact will have to interrupt would cause the contact to be destroyed in a very short time. A control winding is therefore placed on the commutating reactor core, and this winding is energized in such a way that the required negative ampere turns for changing the flux from positive to negative saturation is supplied by the control winding instead of the main winding, resulting in a step current in the main winding of zero value. The length of the step is a function of core cross section, number of turns of main winding, and the voltage impressed across the main winding during the step. It is independent of the load current and the rectifier can therefore be operated between zero and maximum guaranteed overload current, usually 150 per cent.

The d-c output voltage of the rectifier can be controlled in downward direction only, similar to a mercury arc rectifier, by choosing the point in the voltage wave where the commutation is initiated. The greater the delay the lower the resultant d-c voltage. The rectifier can be equipped with automatic voltage control to give constant current, constant voltage, or constant wattage as required by customer.

The contact mechanism utilizes reciprocating contacts. The contacts are silver, which so far has been found to be the most satisfactory material, combining high conductivity with reasonable life. The schematic illustration (Figure 4) shows the contact operating mechanism, for one phase, consisting of an eccentric rotated by the synchronous motor, oscillating by means of a connecting rod, a rocker arm which in turn imposes a sine motion to each of two contact push rods, one mounted on each side of the pivot of the rocker arm. This arrangement places the two contacts 180 electrical degrees apart, permitting a bridge connection of the contacts, which in turn results in a 6-phase rectification from a 3-phase transformer. Reciprocating contacts are used rather than rotating contacts because a much smaller contact ($1\frac{1}{8}$ in. diam for a 5000-amp machine) can be used, friction losses are eliminated, contact life increased and ohmic drop through the contacts is considerably smaller. Furthermore, changing of contact time, both individually as well as collectively, can be easily obtained.

It is of prime importance that the contacts seat as flat as possible, no rocking motion is permitted nor must the contact surfaces slide on each other after seating, if long contact life is to be realized.

The mechanical rectifier is available in the following rated sizes, 50-amp, 200-amp, 625-amp, 1250-amp, 2500-amp, 5000-amp, and 10,000-amp in one unit, all for operation at d-c voltage between 50 and 400 volts as specified. The 400-volt maximum is the natural limitation of one set of contacts and the 50-volt minimum is a commercial limitation, below this value the mechanical rectifier is no longer competitive with other conversion equipment, except where very large currents are required, for example, 100,000 amps or higher at 15 to 20 volts. Here the power saving made possible by the inherent high efficiency of the mechanical recti-

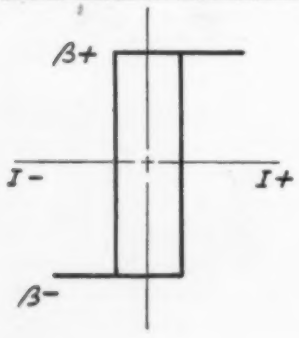
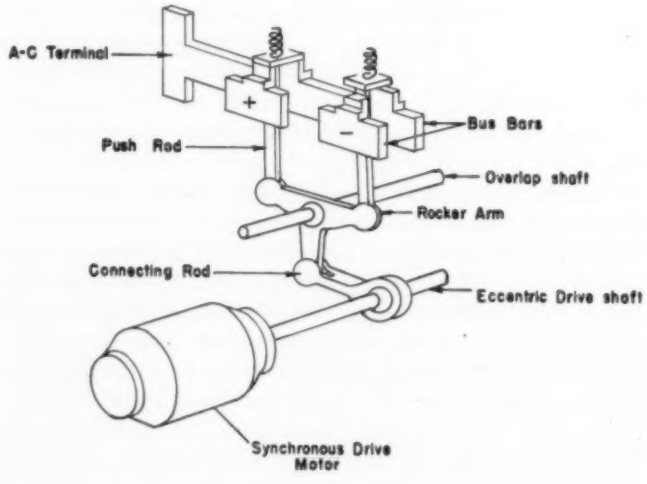


Figure 3 — Magnetization curve in core material used in rectifier.

Figure 4 — Schematic diagram shows contact operating mechanism.



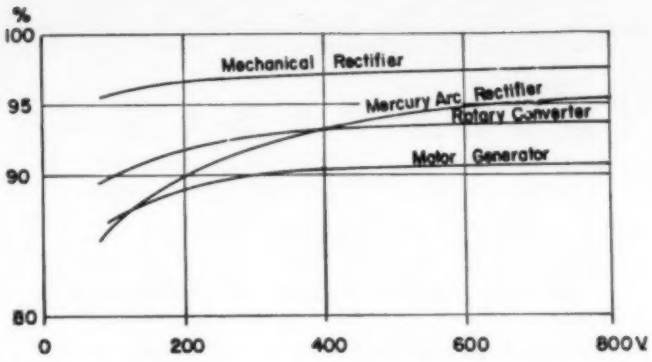


Figure 5 — The curves show that the efficiency of the mechanical rectifier is greater than other common types of conversion equipment, especially in the low voltage range.

fier makes it possible to amortize the higher investment cost in a relatively short time.

The advantage of the mechanical rectifier is primarily its inherent high efficiency in its voltage range (Figure 5). Further advantages are small space requirement, low installation cost due to completely factory wired units. The installed cost therefore compares very favorable with other conversion equipment. No crane service is required, which further lowers the installed cost. As there are no large rotating masses to accelerate, and no warming up period is required, the machine is instantly available. Few auxiliaries are required and maintenance is low. The major items requiring replacement are the contacts which have an expected life of 18 months. Replacement of contact is extremely simple and can be made in 10 minutes for a 5000-amp machine. The life of mechanism bearings is better than 50,000 hours and a complete new set of bearings can be installed in 12 hours at a cost of less than $100.00.

The limitations of the mechanical rectifier are:

1. Relative low power factor (86-90 per cent).

2. The tendency to backfire (a) by overloading beyond its guaranteed overload capacity, (b) by interruption or loss of 60 per cent of a-c voltage. In both cases the contact mechanism is protected against severe damage by short circuiting both the a-c and d-c sides of the mechanism by means of an ultra-high speed (0.001 sec) device which operates whenever the a-c input does not balance the d-c output. After the short circuiting device operates, the d-c breaker trips due to reverse current, and the a-c breaker trips due to overload. The short circuit stresses on the a-c side are moderate because the commutating reactors are left in the circuit. They will produce the step (Figure 6) and the short circuit current is therefore only approximately half of the value it would assume if the reactors were not in the circuit. Due to the step, the interrupting duty of the a-c breaker is materially reduced. The net damage to the mechanism whenever a backfire occurs is that one or at most two contacts are burned and they should be replaced at the first opportune time.

Two fairly large installations have been made to date. At Buffalo Electro-Chemical Co., Buffalo, N. Y., two units rated at 3500 amps, 280 volts, d-c each, and each capable of operating continuously at 5000 amp have been in operation since February 8, 1949 (Figure 7). The second installation comprising two 5000-amp, 100-volt, d-c units was placed in operation during the

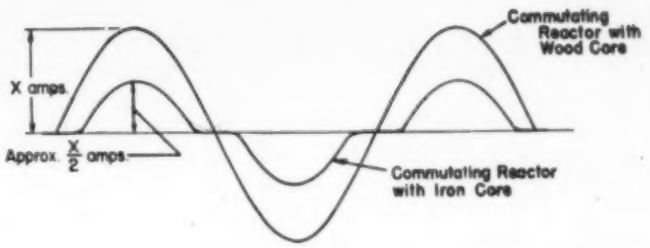
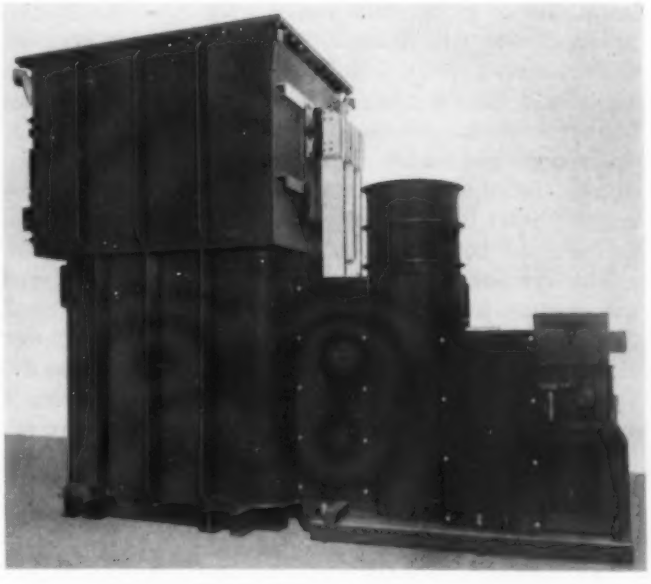


Figure 6 — Limitation of short circuit current by means of commutating reactor.

month of August, 1949, at the Shawinigan Falls plant of the Canadian Resins & Chemicals Co., Ltd. The two installations are similar but the Buffalo installation is operated at 25 cycles and the Canadian installation is operated at 60 cycles. Both installations operate 12 phase. Operating experience gained in Buffalo has been very gratifying. With the exception of a water leak at the shaft seal of the coolant pump, no trouble has been experienced. The shaft seal trouble had been anticipated and new pumps with better shaft seals were ready for installation when the trouble occurred. The Buffalo units are operating satisfactorily in parallel with two ignitron rectifiers, while the Canadian units are operating independently.

In Figure 8 is shown the schematic wiring diagram of the Buffalo installation. The main supply is 11,000 v, 25 cycle. A standard oil circuit breaker protects each of the two transformers, one of which is star connected, the other delta connected on the primary side in order to obtain 12-phase operation. The secondary of both transformers is delta connected. The *OCB'S* are equipped with CO relays, the time delay feature of which is set at 160 per cent of rated current and is used for overload protection. The instantaneous feature of the CO relays is set at four times normal current and is used for short circuit protection. A set of four current transformers is installed between the secondary transformer terminals and the commutating reactors. Three of the current transformers are used for the operation of the

Figure 7 — Mechanical rectifier contactor and choke coil assembly for Buffalo Electro-Chemical Co.



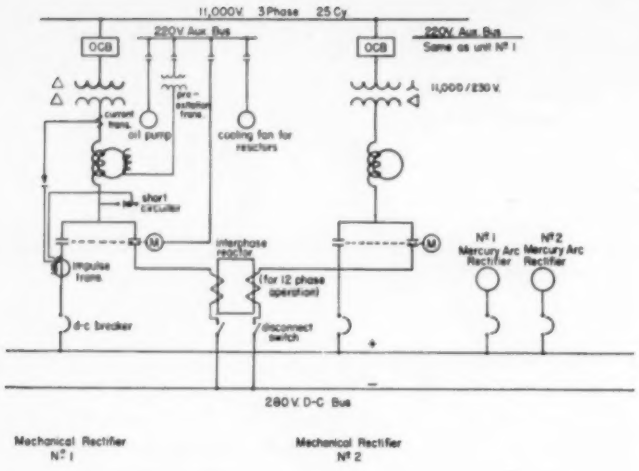


Figure 8 — Schematic wiring diagram for installation at Buffalo Electro-Chemical Co.

short circuit device, and the fourth current transformer is used for the operation of the constant current regulator. The constant current regulator originally supplied did not operate satisfactorily and it will be replaced with a new regulator in which the contact making relay will be replaced with a magnetic amplifier, and a hydro-servo mechanism will be used for the shifting of the motor stator instead of the motor driven gear reducer now employed. The three commutating reactors for each unit are connected between the secondary transformer terminals and the contact mechanism. The pre-excitation circuit of the commutating reactors consist of two transformers, one fed from the secondary of the main transformer, the other from the auxiliary circuit. This arrangement automatically adjusts the pre-excitation, regardless of the tap position of the main transformer. In the positive lead of each contact mechanism is inserted an impulse transformer for control of the short circuiter and a high speed breaker for protection of the d-c side of the rectifier, and for connecting the unit to the load. In the negative lead is placed an interphase reactor for multiphase operation, and a disconnect switch for complete removal of the unit from the negative bus. The auxiliary circuit is fed from a 220-v, 3-phase source available at the time of installation.

The auxiliary equipment consists of the synchronous drive motor, a motor which drives the coolant circulating pump, the oil pump, for force feed lubrication of the mechanism and the coolant fan, a fan motor for cooling the commutating reactors, and a contactor for the control of the pre-excitation circuit. The short circuiter is reset by means of a small bottle of compressed air.

The synchronous drive motor is specially designed with a very small rotating mass, and a high pull out torque. It will follow any ordinary frequency change of the a-c network. Several smaller units have been delivered and are performing well within their prescribed specifications.

Improvements will undoubtedly be made as the mechanical rectifier art progresses. It is however, felt that a good start has been made in introducing the mechanical rectifier to American industry.

DISCUSSION

PRESENTED BY

A. SCHMIDT, JR. and L. W. MORTON, Power Electronics Division, Industrial Engineering Divisions, General Electric Co., Schenectady, N. Y.

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OTTO JENSEN, Manager Rectifier Division, I-T-E-Circuit Breaker Co., Philadelphia, Pa.

A. Schmidt, Jr., and L. W. Morton: Our company has followed the development of the mechanical rectifier in Europe, and later in this country, with keen interest. We are grateful to Otto Jensen for technical papers he has prepared which report the progress that he and his associates are making. When a new development of this sort is brought forth, much information with regard to the capabilities and limitations of the apparatus is needed by those interested in its design and use.

Successful commutation of the d-c load current from phase to phase, under varying conditions of load, confronts the mechanical rectifier designer with a tough problem. This problem is absent in the electronic or metallic rectifier, because the latter contains rectifying devices which permit the flow of current in only one direction. Thus, the valve action of the electronic and metallic types automatically provides the basis for successful commutation, under all conditions of varying load. In comparison much has to be added to the mechanical rectifier to obtain a satisfactory substitute for this valve action.

These additions are of course the special commutating reactors described by Mr. Jensen, and the precise timing system with its control which is embodied in the mechanical component. It is worthwhile studying some aspects of these additions, to determine whether they impose any practical limitations on operating characteristics. Are they as suitable for rapidly fluctuating loads, such as steel mill, mining and electric railway service, as they apparently are for steady loads of the electro-chemical type?

Reference to technical articles published by the inventor of the mechanical rectifier, Floris Koppelman, is of great assistance. The series: "The Kontactumformer" published in Elektrotechnische Zeitschrift Jan. 1941; "Kontactumformer fur Hochstromanlagen" in Technische Beschreibung AJE Nr. 98; "The Electro-Technical Principles of the Contact Converter" in three parts in Elektrotechnik und Maschinenbau 1941, V. 59, No. 23/24, 1942 V. 60, No. 17/18, and 1942 V. 60, No. 35/36; and Verfahren zur Messung von Ringkernen, in Archiv fur Elektrotechnik, 38 Band Heft 3/4, 1944, give detailed data on all features. This source may be considered valuable and authentic, especially because comparison of many of the illustrations and data used by Mr. Jensen in this paper and others presented by him earlier, with those appearing in the Koppelman articles, discloses that they are identical.

LIMITATIONS OF THE COMMUTATING REACTORS

The magnetization curve of the core material used in the commutating reactors, Figure 3 of the author's paper, is idealized. It would have been more illuminating if measured characteristics of the core material had been used. These true magnetization curves have slanting instead of exactly vertical and horizontal portions, which join each other in curves instead of right angles.

The departure of the actual from the idealized magnetization introduces a factor which was not fully discussed by the author, but which seems to require compensation. Otherwise, sparkless contact operation and acceptable contact life, together with stable operation over wide load range and rapid load fluctuation, will not be obtained.

If the magnetization curves actually conformed to the ideal, there would occur a truly flat "step" such as shown by the author, during any part of which a contact could be broken at zero current, without a spark. However, instead of a truly flat zero current "step," any practical commutating reactor produces a slanting "drag out" period involving finite current. The instant when this slanting "dragged out current" passes through zero is affected by such factors as: amount of presaturation, load current, applied voltage, and amount of phase control. Only, if the opening of the contact is timed to coincide with the point where the "dragged out" current passes through zero will sparkless contact operation be obtained.

Much of Koppelman's published data deals with efforts to make the contact opening coincide with the point where the "drag out" passes through zero current; and it is safe to say that he recognized it as a serious limitation of the mechanical rectifier. For instance, the overlap shaft shown in Figure 4 of the author's paper, also appeared in an identical illustration by Koppelman (in Technische Beschreibung). The purpose of this overlap shaft is to provide a means of adjusting contact "dwell" time in order to obtain this desired coincidence.

Much effort seems to have been put forth to develop a regulator which could be attached to the overlap shaft. The purpose of this regulator was to automatically adjust the contact "dwell" time to compensate for all the various loading conditions which effect the point where the "drag out" current passes through zero. It is not clear that a simple and successful regulator for this purpose has been produced.

On the other hand this is not surprising because the objective is so difficult. For rapidly fluctuating load conditions often met in industry and transportation, an extremely high speed regulator would appear desirable. As the regulator must be of the mechanical type, serious time delays may be difficult to avoid.

Of course it may be argued that the contact can be opened any time during the "drag out" period. Admittedly, this causes sparking, contact erosion, and shortened contact life. But what of it?

With respect to this alternative Koppelman has indicated, and common sense would seem to dictate, the wisdom of avoiding operation under anything but sparkless commutation.

The foregoing analysis of commutating reactor limitations has been somewhat involved. What it means in plain language is that these mechanical rectifiers seem to be more suitable for fixed loading conditions of the electrochemical type than for rapidly fluctuating and wide range loads. It therefore appears that the problem of providing automatic contact "dwell" time, to compensate for phase control and load changes must be solved before using the mechanical rectifier for steel mill, mining or electric railway service at least in any but the smaller sizes. If this is not true we would like to have an explanation from the author, with suitable supporting operating experience.

MINIMUM LOAD REQUIREMENTS

There is another limitation connected with this particular type of mechanical rectifier which deserves consideration. In practice it is necessary to maintain the d-c load above a minimum value. The instantaneous load current must always exceed the saturating current for the commutating reactors. Otherwise the "drag out period" provided for commutation may be too short. This minimum load is significant in magnitude. If it is not maintained, arc-over of the contacts and interruption of service results.

Experience with most industrial, mining and railway loads indicates that there is rarely assurance of minimum base loads on a 24-hour basis, although the conversion equipment is usually kept in service on a 24-hour basis. It appears, therefore, that for many of the later applications a substantial dummy load will be mandatory. These continuous extra losses will probably offset or greatly reduce the high efficiency of the mechanical rectifier under loaded conditions.

FAULT CURRENT DURING ARC-OVER

Figure 6 of the author's paper may be misleading. The identical illustration, even to actual values of current, appears in Koppelman's article, "The Kontactumformer," Figure 30. Mr. Koppelman does not give the rating of the rectifier or commutating reactor used for making this test but it is obviously smaller than the units described in Mr. Jensen's paper.

We would like to know if any tests have been made on the large units installed in North America to support the conclusion that "the short circuit current is therefore only approximately half of the value it would assume if the reactors were not present in the circuit." Otherwise we believe the conclusion is illogical if based only on the Koppelman test.

The foregoing comments are intended to provoke realistic consideration of the problems faced by the designers of mechanical rectifiers, and also those who expect to apply and use them. It is not meant to detract in any degree from the excellent contributions made by the author and his associates. Everyone familiar with the work which has been done by them appreciates the great courage and effort which they have concentrated on continuing the development of the mechanical rectifier in the U. S.

Harold Winograd: Mr. Jensen and his company

should be complimented for the work they have done in introducing the mechanical rectifier in this country. It undoubtedly has been a difficult and costly undertaking, and they are making a valuable contribution to the electrical industry.

The mechanical rectifier has application possibilities in the low-voltage high-current electrochemical field, such as the 100-volt Canadian installation mentioned by Mr. Jensen, where mercury-arc rectifiers cannot be applied economically.

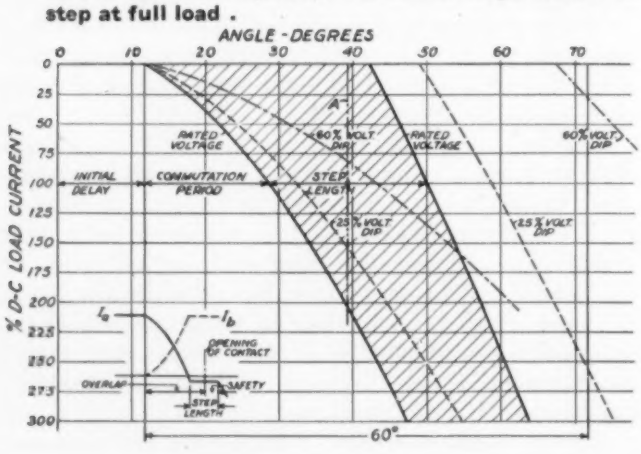
Mechanical rectifiers are actually much older than the mercury-arc rectifier, which was invented about 47 years ago. Attempts to build mechanical rectifiers were made about 80 years ago and many times since then. Past efforts to produce such a rectifier for higher currents were unsuccessful, because of commutation difficulties and short contact life.

The essential difference between the operation of a mercury-arc rectifier and a mechanical rectifier is that the mercury-arc rectifier is a uni-directional device, while the contacts of a mechanical rectifier can carry current in both directions. When the current in one phase of a mercury-arc rectifier has reached zero at the end of a commutation period, its circuit is opened by the inherent valve action of the rectifier, which prevents current reversal. In a mechanical rectifier, the contact must open when the current has reached zero; otherwise the current will reverse and result in a short-circuit. In a 6-phase, 60-cycle rectifier, the operation is repeated 360 times a second.

The mechanical rectifier developed in Germany proved more successful than its predecessors because of the commutating reactors with cores of a special magnetic alloy, which was produced in Germany during the war. As explained by Mr. Jensen, the reactor introduces a short interval of practically-zero current, at the end of the commutation period, to permit opening of the contact without an arc. The duration of the step is approximately 1 millisecond or 6 hundredths of a cycle at 60 cycles. If the contact should open either ahead or after this step, arcing and a short-circuit would result.

The post-commutation step is the basis of the successful operation of the mechanical rectifier. I should therefore like to examine it in greater detail, under variable operating conditions, with the aid of Figure 9. In the lower left-hand part of this figure is reproduced Figure 2c of Mr. Jensen's paper.

Figure 9 — Commutation diagram of mechanical rectifier. Commutation period is based on a total circuit reactance of 10 per cent at 60 cycles. Step length at full-load and rated voltage equals 1 millisec. Line A represents time of contact opening drawn through center of step at full load .



The step always starts at the end of the commutation period. At constant load current and constant a-c voltage, the length of the commutation period is constant, and the position of the step in the cycle remains unchanged. These are the optimum operating conditions for a mechanical rectifier. If the load current increases, the commutation period increases and the step is shifted in the lagging direction. A drop in the load current has the opposite effect, and the step is shifted in the leading direction. A drop in the a-c supply voltage also increases the commutation period and shifts the step.

The curves in Figure 9 show the effect of changes in load current and a-c voltage on the length of the commutation period and the position of the zero-current step, for a mechanical rectifier operating at 60 cycles. These curves were based on a total circuit reactance of 10 per cent and on the assumption that the commutating reactors provide a one-millisecond step at full load. The 10 per cent reactance might be made up of 4 per cent for the rectifier transformer, 5 per cent for the commutating reactors, and 1 per cent for the a-c system.

The shaded area, enclosed by the solid lines, shows the position and length of the step at rated voltage. The vertical line *A* shows an assumed position for the opening of the contact. It was drawn through the middle of the step at full load. Actually, the opening position of the contacts should be represented by a band rather than a line, due to slight inaccuracies that are bound to enter into a mechanical system of this type.

It can be seen that at light loads the contact opening is too close to the end of the step, while at higher loads it gets close to the commutation period. The ideal arrangement would be to shift the opening point of the contact as the load changes. This is possible in applications where the load can be controlled at will, which is the case in some electrochemical applications. However, in most industrial applications and in railway and mining service, the load can vary over wide limits and the load variations cannot be anticipated. It would not be practical to shift the contacts to follow the load swings, because a number of cycles would be required to shift the contacts, while the effects we are considering here occur every one-sixth of a cycle. The best that could be done is to set the contact opening for average load conditions and hope that the load limits will not be exceeded.

Mr. Jensen stated in his paper that the load limit for a mechanical rectifier is 150 per cent of full load. However, conversion equipment for industrial service has a rating of 200 per cent for one minute. For mining and railway service, the equipment is rated at 150 per cent load for two hours and 200 or 300 per cent for one minute. Even higher momentary swings can be expected occasionally due to short-circuits on the d-c system.

Due to the inherent load limitations of a mechanical rectifier, it is doubtful whether it could be used safely for these applications, except in special cases where the

range of load swings is kept within prescribed safe limits.

The other curves in the figure show the effects of dips in the a-c system voltage. Mr. Jensen stated that a mechanical rectifier can ride through voltage dips up to 60 per cent. This condition is represented by the dot and dash lines in the figure. It can be seen that a dip near this magnitude is definitely beyond the safe limit, except at light loads. When the voltage drops, the load current would also drop. However, there would be a delay in the drop of the load current, due to the inductance of the d-c circuit. The delay is likely to be considerably longer than one-sixth of a cycle.

The dashed curves represent conditions during a 25 per cent dip in a-c voltage. The mechanical rectifier would ride through such a dip if the load current is not too high. A dip in the voltage has the effect of shortening the load limit.

The load limit of a mechanical rectifier can be increased by increasing the size of the commutating reactors in order to lengthen the zero-current step. This, however, would increase the cost and losses. If the reactors are too large, separate reactors have to be used for the positive and negative half-cycles of current, so that 6 reactors would be required insead of 3, which would increase the cost and losses still further.

Operating experience with mechanical rectifiers in Germany tends to confirm this analysis. Most of the higher current installations were for electrochemical service. In installations where operating conditions were stable, good results were obtained. In installations subjected to power system disturbances, frequent outages were experienced and the contact life was short.

I doubt whether it would be safe to operate a mechanical rectifier after a fault without replacing the contacts. This would require a shutdown of at least 10 to 20 minutes, depending on the skill of the maintenance man. A contact life of 18 months mentioned by Mr. Jensen also seems rather optimistic.

The great advantage of a mechanical rectifier over other types of conversion equipment is its higher efficiency, particularly at the lower d-c voltages. However, it lacks the operating stability of a mercury-arc rectifier. In most applications, reliability is a more important consideration than efficiency. It is too early to say anything regarding relative maintenance costs.

There is no doubt that further improvements will be made on the mechanical rectifier. However, some radical changes are necessary to correct its chief handicap of load limitations and sensitivity to system disturbances. Until such improvements are made, its application is necessarily limited.

Otto Jensen: The discussers question the ability of the mechanical rectifier to operate under variable load, such as might be encountered in a steel mill or electrified railroad. It is true that the magnetization curve shown in the paper is idealized and that the actual curve has a slant and rounded corners. The rounded corners merely mean that the full magnetization change cannot be utilized to produce the step, but only from 80 to 85 per cent of the magnetization change can be so utilized. As far as the slant goes, it can be very nicely compensated for. A detailed paper of how this is accomplished together with various control circuits of the commutating reactors will be given later as it is too big a subject to disclose in this answer to the discussers. There is therefore no drag-out of the dwell time. The step is flat and the current which is interrupted by the contacts can be easily adjusted at the factory to obtain arcless interruption, regardless of load. The mechanical rectifier can operate under variable load conditions within its guaranteed minimum and maximum current rating.

The minimum or base load requirements are relatively small. On steady load machines the base load is automatically disconnected when the machine is carrying load and connected when the load drops off.

At Buffalo the base load is 20 amp and at Shawinigan Falls it is 25 amp. In each installation the base load would constitute a loss of ½ per cent if it was connected continuously.

In regard to the fault current, tests have been made in this country substantiating Koppelman's tests. Furthermore the fault current can be easily calculated both with and without the commutating reactors in the circuit. We do not believe these calibrations to be of general interest, but shall be happy to send this information to the discussers if they will further indicate their interest in this matter by requesting this information.

Mr. Winograd's analysis of the limitations of the load possibilities is correct. We are grateful for his diagram which gives a clear picture of the shifting of the step as a function of load. This diagram has been extended beyond the practical limits of a mechanical rectifier utilizing 3 commutating reactors, where the load limitations usually do not exceed 150 per cent. We realize the limitations of this design, but for electrochemical service it is adequate.

If greater overload capacity is required, the 6 reactor circuit can be employed. While this design increases the size and cost of the reactors somewhat, it is purely an economical matter as to the amortization of the slight increase in initial cost of the equipment. The efficiency does not suffer, but a slightly lower power factor can be expected. Other circuits can be used which will make the mechanical rectifier short circuit proof. For mining service, such a mechanical rectifier must be developed before we can hope to enter this field and experimental work is in progress. We would like to have an opportunity to present a paper at some future Association of Iron and Steel Engineers' Convention when this problem has been solved.

It is not the author's desire to enter into a controversy of the merits of the mercury arc rectifier against those of the mechanical rectifier. The mercury arc rectifier today is a reliable piece of equipment, and when the d-c system voltage is above 400 volts it is the only conversion means which should be employed. However, below 400 volts the mechanical rectifier offers advantages which warrant a thorough investigation by prospective users. There is no doubt that the mechanical rectifier, ten years hence will be materially improved over today's model, just as the mercury arc rectifier today is much improved over the mercury arc rectifier offered ten years ago. In order to bring this improvement about, operating experience must be obtained for many more installations.

PREPARED PROTECTIVE ATMOSPHERES

. . . . although prepared atmospheres were originally developed to prevent surface damage to the metal being processed, they can also be used to produce certain desirable properties in the metal surface . . . .

By E. G. deCORIOLIS
Director of Research
Surface Combustion Corp.
Toledo, Ohio

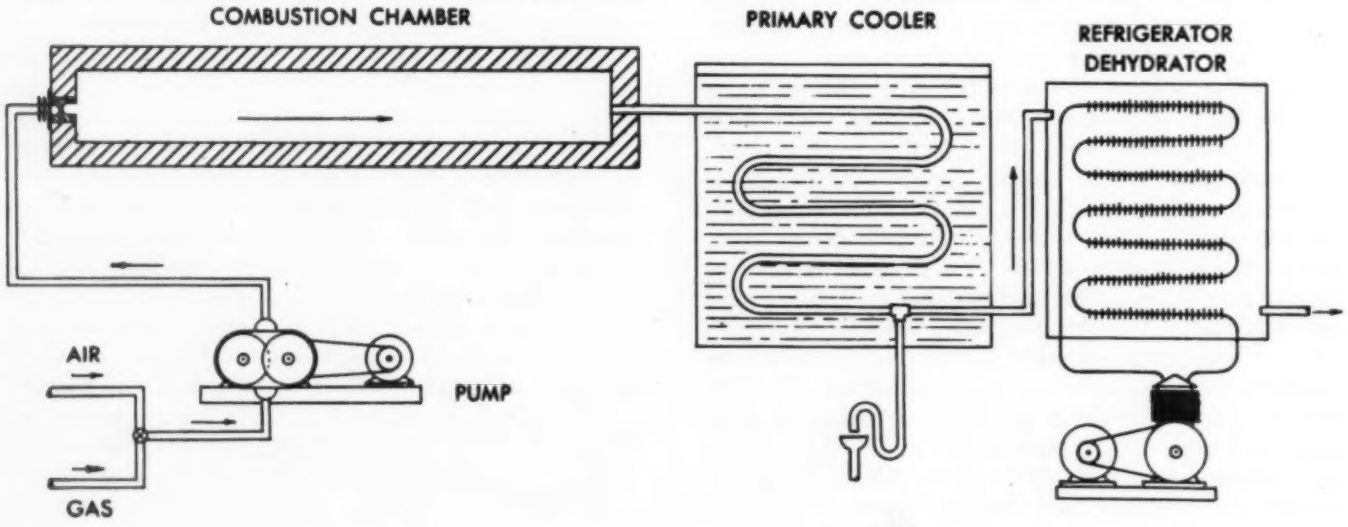
▲ STEEL mill furnace operators have long been aware of the effect of combustion adjustment upon the surface condition of the steel being heated. In direct-fired reheating furnaces such as soaking pits, slab and billet furnaces and normalizers, experience has taught them the best adjustment to provide the least objectionable scale condition for subsequent forming of the steel under various specific conditions. In a broad sense, the combustion products can be considered a protective atmosphere in such furnaces since the combustion adjustment is made to give the most protection consistent with satisfactory heating efficiency. However, this discussion will be limited to consideration of protective atmospheres as gases which surround the steel being heat treated, and which are completely independent of the products of combustion of the steel heating system.

The first such protective atmospheres to be used in the basic steel industry were raw natural gas and coke oven gas, in the box annealing of sheet. With gases so rich in methane, an objectionable amount of carbon was usually deposited upon the steel. However, deoxidation of the steel took place and, except for the discoloration at the edge of the sheets, the product on the whole was satisfactory.

Galvanizing stock was an exception in that the oxide formed in direct-fired annealing was preferable to the carbon deposited by the protective atmosphere, since such oxide was more readily removed in the subsequent pickling operation. Desulphurized coke oven gas is still used as an annealing atmosphere in a few plants, but the steel industry as a whole has adopted prepared protective atmospheres for the vast majority of its annealing operations.

The first prepared protective atmosphere to be introduced in the mills was one formed by the partial combustion of fuel gas and commonly designated "DX Gas." Letter designations such as "DX" will be employed rather frequently in this paper for brevity and convenience in referring to a particular type of prepared gas atmosphere. It should be emphasized that the gas atmospheres referred to in this manner are generic types rather than the atmospheres produced in a particular brand of generator equipment. This gas was adopted nearly 20 years ago for the deoxidation and bright annealing of sheets. The use of DX gas has grown until today it is the most widely used of all prepared atmospheres. Virtually all cold finishing mills are using this gas in some manner. Well over a million

Figure 1 — The flow diagram of a typical DX gas generator shows the principal component parts of a conventional unit.



cfhr of DX gas generating capacity has been installed for annealing operations in this country.

Since the introduction of DX gas to the steel industry, a variety of prepared atmospheres have been developed, most of which use natural gas and air as the raw materials. The following discussion is intended to survey the principal types of atmospheres used today for processing steel at the mill. The most widely adopted of these prepared atmospheres will be discussed individually, including their characteristics, analysis, applications and limitations.

DX GAS

DX gas is prepared by the partial combustion of fuel gas; either natural gas, coke oven gas or petroleum gas; followed by cooling and partial dehydration. It is employed for the bright annealing of cold finished material such as sheets, strip, rods, tubing and other products.

Since DX gas was the forerunner of most prepared protective atmospheres and gases of this type are still the most widely used in the steel industry, it will be discussed in some detail. An understanding of the characteristics of DX gas provides for a better appreciation of the functions of the subsequently developed prepared atmospheres and the reasons for their employment.

DX gas as commonly employed in the steel industry has approximately the following analysis:

CO_2 — 5 to 6 per cent
CO — 9 to 10 per cent
H_2 — 10 to 12 per cent
CH_4 — 0.5 per cent
H_2O — Dewpoint + 40 F
N_2 — Remainder

Method of preparation—Natural gas is most often used as the raw material for combustion, but desulphurized coke oven gas is also employed rather frequently. The combustion takes place in an insulated refractory-lined combustion chamber. The heat of combustion maintains the chamber at a temperature of about 2400 F. The hot gases leaving the chamber are then cooled in two steps, first by water cooling in a primary cooler to about 90 F and second by refrigeration to a temperature of 40 F. The refrigeration step is generally accompanied by mist elimination in order to effect a dewpoint of 40 F in the gas. The water of combustion that is condensed in the two cooling steps is suitably trapped and directed to a drain.

Either one of two types of primary cooler may be employed; an indirect or a direct contact cooler. The indirect cooler is preferred for most applications since this type does not permit the gases to come in contact with the cooling water.

In the direct contact type, the gases are cooled by passing through a spray chamber or a packed tower. The chief objection to the direct contact cooler is that oxygen (air) is picked up by the gas from the water, and in most applications this oxygen will cause discoloration of the steel being treated.

The gases leaving the refrigerator at 40 F with a 40 F dewpoint comprise the finished DX gas. The reason for choosing 40 F as the desired dewpoint is that this is close to the maximum amount of water vapor that can be tolerated in DX gas without causing oxidation to take place during the heating and cooling cycles of the steel. Lower dewpoints result in excessive carbon deposition where long heat treating cycles are involved. This designated temperature is also conveniently attained by refrigeration without constant danger of frosting the cooling coils.

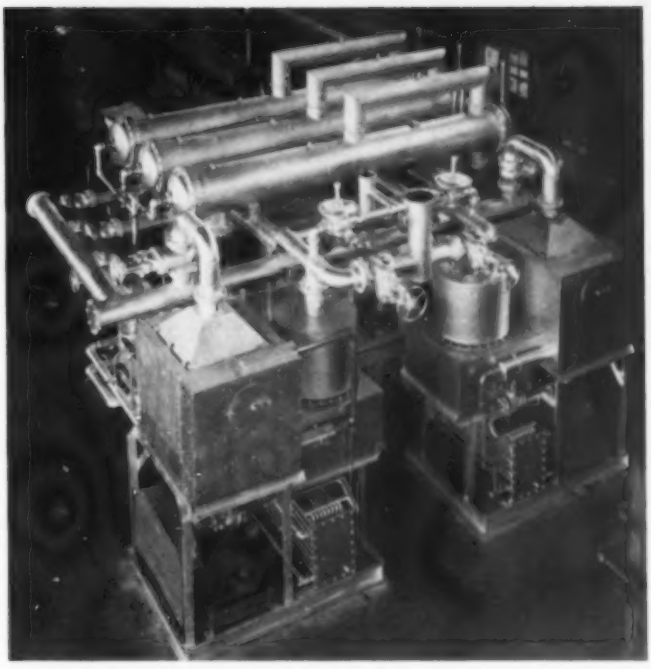


Figure 2 — The DX generator illustrated has a capacity of 35,000 cfhr for use in a steel plant.

The flow diagram, Figure 1, shows the elementary arrangement of the principal component parts of a conventional DX unit. A modern steel mill DX unit is shown in Figure 2.

General characteristics—DX gas will barely support combustion when mixed in approximately equal proportions with air; however, it is necessary to follow accepted purging practice in the application of the gas.

At conventional steel mill annealing temperatures of 1150 F to 1300 F for low carbon steel, DX gas has a deoxidizing effect on steel, hence the name. At temperatures of 800 to 900 F it tends to deposit carbon. At elevated temperatures it is decarburizing to medium carbon steel.

DX type gases have found widespread use due chiefly to their ease of preparation, safety, flexibility and low cost of preparation. With natural gas at 40 cents per thousand cu ft, power at 1 cent per kwh (for motors) and cooling water at 6 cents per thousand gallons, the total cost of utilities and materials is approximately 9 cents per thousand cu ft of finished gas.

Applications of DX gas—DX gas was first employed in the steel industry nearly 20 years ago as a protective atmosphere in the box annealing of sheets. This application proved the forerunner of modern annealing of cold rolled strip which predominantly is performed in radiant tube box annealing furnaces in conjunction with inner covers which surround the charge of steel

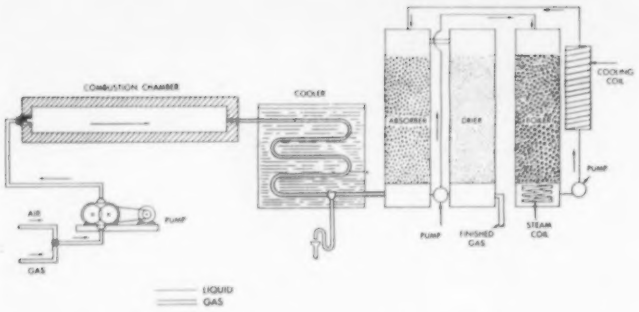


Figure 3 — Flow diagram of typical NX gas generator.

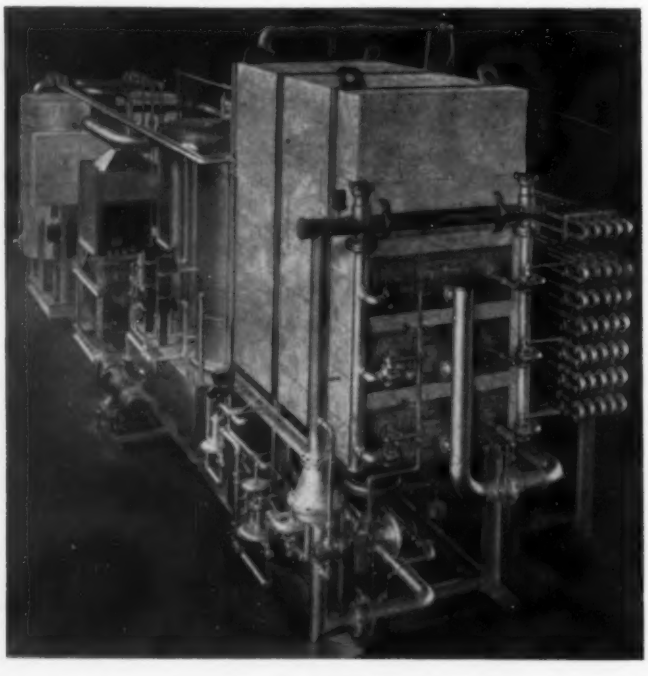
and contain the DX gas. Typical practice is to charge the steel onto a supporting base, lower the inner cover over the steel and seal the inner cover to the base by means of sand, then pass DX gas into the inner cover. When all air has been purged from the inner cover, the annealing furnace is placed over the cover and heating commenced. When the steel has been soaked at the required temperature for the required time, the furnace is removed and the steel allowed to cool within the inner cover. A flow of fresh DX gas is maintained throughout the heating and cooling cycles, which serves to protect the steel from oxidizing. The foregoing practice applies generally to the annealing of stock for tin plate, galvanizing, enameling sheets and auto body stock, following cold reduction. It also applies to the annealing and spheroidizing of cold-drawn rod and wire as well as bar stock. In all of the above applications, it is essential that the DX unit be provided with an indirect type of primary cooler if a deoxidized surface is required on the steel processed.

Cold drawn tubing is generally annealed in an atmosphere of DX gas in a continuous roller hearth type furnace heated either with radiant tubes or with electric elements. In this type furnace the entrance and exit openings are made as small as feasible for the production involved and air infiltration is prevented by introducing sufficient volume of DX gas into the furnace to maintain a slight positive pressure within the furnace. In some fast cycle applications it is possible to produce fairly bright work in this type of furnace with a DX unit equipped with a direct contact primary cooler, although the indirect type cooler is preferred. During the war virtually all steel cartridge cases were treated in roller hearth furnaces with DX gas atmosphere.

In general, DX gas is used to prevent oxidation of steel during annealing at the mill. It is a fairly good surface deoxidizing gas. Steel that has been blued or otherwise discolored by slight oxidation can be made bright by heating to annealing temperature (1150-1300 F) in an atmosphere of DX gas. However, with the long cycles involved in heavy tonnage annealing in cover type furnaces, DX gas has a tendency to produce "black borders" or "snakes," as this effect is termed in the industry, on the edge of coiled strip, which today often proves troublesome in electrolytic tinning lines.

DX gas is used in virtually all steel mills producing a cold reduced product which requires annealing. Some mills employ as high as 200,000 cfhr. Sizes of individual units range from 500 to 35,000 cfhr.

Figure 4 — The 15,000 cfhr NX generator was built for tin plate annealing.



NX GAS

NX gas is a higher nitrogen modification of DX gas. It is also produced by burning of fuel gas with a deficiency of air to assure an absence of free oxygen. Elimination of practically all of the CO_2 and water down to a dewpoint of –40 F mean that this gas is essentially a high nitrogen atmosphere. A typical approximate analysis is as follows:

CO_2 — 0.1 per cent
CO — 1.0 to 4.0 per cent adjustable
H_2 — 1.1 to 4.5 per cent adjustable
CH_4 — Trace
H_2O — Dewpoint minus 40 F
N_2 — Remainder

Method of preparation—Natural gas is almost completely combusted with air to produce a flue gas containing a low percentage of CO and H_2. CO_2 formed during combustion is absorbed out of the gas with a water solution of monoethanolamine, and the water vapor is removed by means of primary cooling to 90 F, refrigeration to 40 F and adsorption by activated alumina to produce a substantially bone-dry gas consisting essentially of nitrogen.

Monoethanolamine, commonly called "amine," or "mea," is an organic chemical which has the ability to efficiently absorb CO_2 from gases at a temperature of 90 F. When heated to 200 F or higher, the amine will release the absorbed CO_2. In the NX unit, amine is employed at a 10 to 15 per cent solution in water. This amine solution is recirculated in a closed circuit which includes a reboiler for boiling the solution to drive off the absorbed CO_2; an indirect water cooler for cooling the freshly-boiled solution to an efficient absorbing temperature; an absorber tower in which the cooled solution is passed into absorptive contact with the flue gas being treated.

Amine solutions have been so employed in the chemical industry for many years. Steam and other sources of heat are used for reboiling the amine solution to drive off the CO_2.

In the flow diagram of Figure 3, the elementary arrangement of an NX unit is depicted while Figure 4 depicts typical steel mill installations of NX type atmosphere generators.

General characteristics—NX gas will not support combustion and is therefore entirely free of explosion hazard, and makes an excellent purge gas for equipment employing gases which form explosive mixtures.

At conventional mill annealing temperatures of 1150 to 1300 F for mild steel, NX gas is deoxidizing. It is substantially inert to carbon in steel over a wide temperature range. It will prevent oxidation of steel even at forging temperatures. There is only a very slight tendency for the gas to deposit carbon in the temperature range of 800 to 900 F.

In furnaces employing NX gas, low dewpoints can be maintained since there is little reaction between the constituents of the gas when the gas is heated. This is in contrast to DX gas in which the constituents react to effect various dewpoints at various temperatures by the well-known reversible reaction:

$$\begin{matrix} CO_2 + H_2 \\ CO + H_2O \end{matrix}$$

For example, DX gas having a 40 F dewpoint at the generating unit will react with itself to provide a dewpoint of 80 F to 90 F at conventional annealing temperatures and to even higher dewpoints at higher temperatures. The reason for the stability of NX gas is that both the CO_2 and H_2O are virtually zero.

With the same assumed costs of utilities and materials presented in the discussion of DX gas, NX gas is made at a cost of approximately 10 cents per thousand cu ft which is only slightly more than that of DX gas.

Applications of NX gas—NX gas was applied during the war as a protective atmosphere in the heating of steel for forging into propeller blades. The steel so protected was virtually oxide-free when put into the forging presses and resulted in a more uniform finished product. Approximately 100,000 cfhr of NX gas capacity was employed for this purpose in a single installation. Recent advances in the heating of steel for forging have made the use of NX atmosphere gas for this purpose economically impracticable except for very special cases.

NX gas is used today in the steel industry for a variety of purposes. In the annealing of tin plate stock for electrolytic tinning lines, NX gas has been proved to be superior to DX gas as a protective atmosphere during annealing. To a great extent the "black borders" often produced by DX gas are eliminated when NX gas is employed. The result is a superior electrolytic product since any borders on the strip show up on the finished product. The probable reasons for the superiority of NX gas over DX gas in this application are the relative stability of the NX gas and its lower percentages of oxygen and carbon-containing constituents. Approximately 100,000 cfhr of NX gas capacity are in current use for tin plate stock.

In many of the new continuous strip treating furnaces for galvanizing and silicon steel production, where a high hydrogen atmosphere provides the basic steel surface treatment, NX gas is used as a purging and conditioning gas for the furnace. For example, when one of these furnaces has been opened up to the atmosphere, air and water vapor permeate the furnace. Prior to resuming production, NX gas is admitted to the furnace to purge it of oxygen and water vapor and, when properly conditioned, the hydrogen gases are introduced. In the event of failure of the source of hydrogen, or if the furnace must be opened up for any reason, a quick purge must be applied to eliminate the hydrogen from the furnace, before it can mix with infiltrated air and cause a serious explosion. NX gas has proven ideal for such applications since it is a very dry stable gas which is inert to combustion and is relatively inexpensive to produce in quantities.

In addition to being the purge and conditioning gas in such continuous strip furnaces, NX gas is often used as a diluent for the high hydrogen atmosphere in certain zones of the furnace, to reduce the cost of opera-

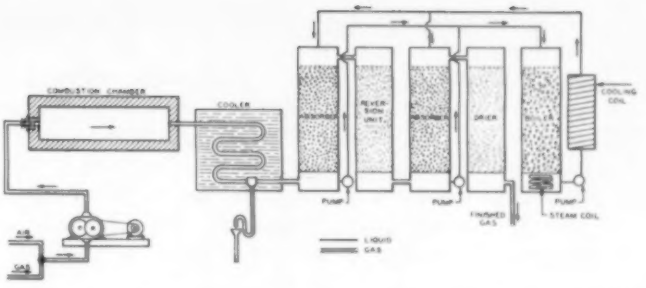
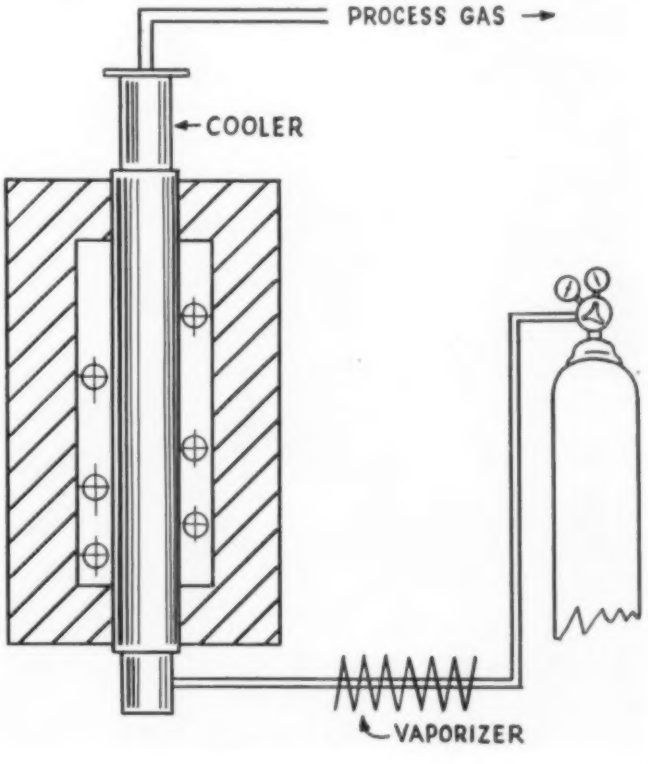


Figure 5 — The flow diagram for the production of HNX gas shows that an additional CO_2 absorption tower is required over that used in a typical NX generator.

Figure 6 — As shown by the schematic flow diagram dissociation of ammonia is a relatively simple process.



tion and to minimize the explosion hazard in normal production.

In the specialty steel field, NX gas is being used to prevent decarburization of medium and high carbon rod and bar stock. When enriched slightly with a carburizing gas, NX gas is used to restore surface carbon to stock that has been decarburized at the hot mill.

The total installed capacity of NX units in the steel industry is approximately 250,000 cfhr.

HNX GAS

HNX gas is the newest modification of the annealing gases and represents another step in the development of controlled atmospheres for the processing of steel mill products to higher standards of quality.

The preparation of HNX gas is similar to that of NX gas but an additional process is introduced into the operation. After the CO_2 is removed by the amine solution, the gas is passed through a reversion chamber in which the CO and H_2O react to form H_2 and CO_2. The process follows the well-known water-gas reaction, in reverse, proceeding to the virtually complete elimination of CO when carried out with a catalyst at a suitably low temperature.

$$CO + H_2O \rightleftarrows CO_2 + H_2$$

The equipment used to prepare HNX gas is similar to that employed for NX gas except that an additional CO_2 absorption tower is required to eliminate the CO_2 formed in the reversion process. This process is represented schematically in Figure 5. Refrigeration to a 40 F dewpoint and adsorption with activated alumina lead to an atmosphere gas which is practically bone-dry. A typical analysis of this gas is shown below:

CO_2 — 0.05 per cent
CO — 0.05 per cent.
H_2 — 3.0 to 10.0 per cent (adjustable as required)
CH_4 — Trace
H_2O — Dewpoint minus 40 F
N_2 — Remainder

General characteristics—HNX gas is similar to NX gas in that it will not support combustion and therefore is an excellent purge gas.

At conventional mild steel annealing temperatures of 1150 to 1300 F, HNX gas is both deoxidizing and slightly decarburizing, when applied in the cover type annealing furnace.

Like any NX gas it is very stable, and since virtually all carbon and oxygen have been removed from the gas, it will not deposit carbon at any temperature.

With the same assumed costs of utilities presented in the discussion of DX gas, HNX gas will cost approximately 12¢ per thousand cu ft.

Application of HNX gas—HNX gas is a new development which should find numerous applications in the steel industry where new process requirements call for an inexpensive hydrogen-nitrogen protective atmosphere to meet certain product quality requirements.

At the present date of writing there is one 20,000 cfhr HNX unit in commercial operation for the annealing of tin plate stock. It is too early to draw definite conclusions, though HNX appears to provide a protective atmosphere superior to DX or NX for this application.

HNX is intended to provide an annealing atmosphere for tin plate stock which will have a superior corrosion resistance. Other applications are under intensive study at the present time.

Dissociated ammonia—Dissociated ammonia gas is employed as a protective atmosphere for certain special annealing processes where its comparatively high cost per unit volume can be justified by the special product quality characteristics derived from its use. Such processes include the annealing of some galvanizing stock for continuous galvanizing processes and stainless grades. Dissociated ammonia is produced by vaporizing anhydrous ammonia; heating the vapor to a temperature of 1600 to 1800 F in a vessel containing a catalyst; and cooling the resultant dissociated mixture. The reaction is:

$$2\ NH_3 + \text{heat} \rightleftarrows N_2 + 3\ H_2$$

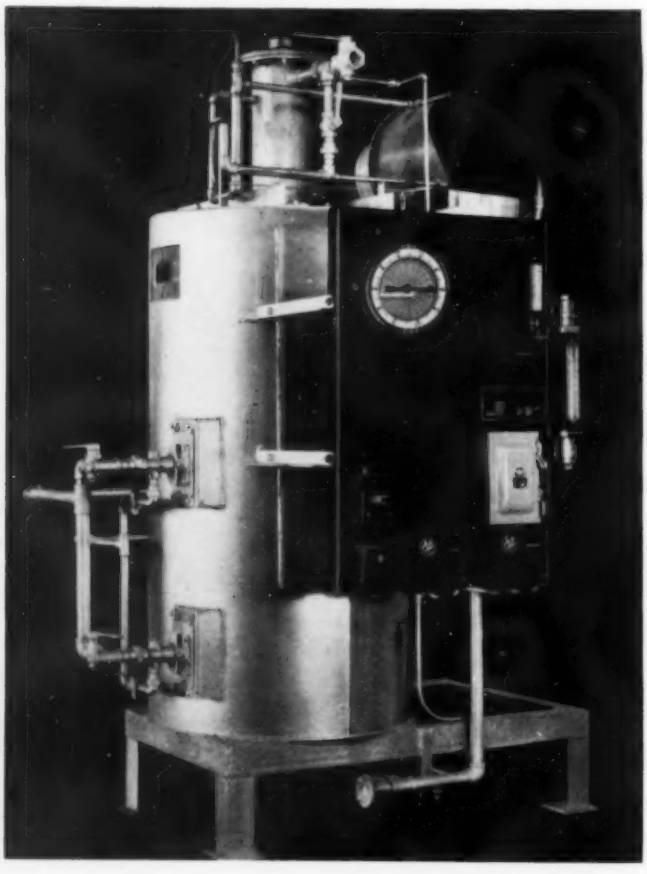
This reaction readily goes substantially to completion. No dehydration of the dissociated gas is required. The diagram of Figure 6 shows the elementary arrangement of an ammonia dissociator, and a typical small dissociator is illustrated in Figure 7. The analysis of the dissociated ammonia gas is as follows:

H_2 — 75 per cent
N_2 — 25 per cent

General characteristics — Dissociated ammonia can be highly explosive due to its high hydrogen content. In furnaces using this gas, great care must be exercised to prevent the mixing of air with the dissociated ammonia within the furnace.

Dissociated ammonia is a strongly deoxidizing gas. It is inert to steel and to carbon in steel at ordinary

Figure 7 — In this ammonia dissociator, 1 lb of anhydrous ammonia yields 40 cu ft of gas.



heat treating temperatures. When mixed with water vapor, it can be made strongly decarburizing.

With tank-car anhydrous ammonia at 4¢ per lb, the ammonia cost alone is $1.00 per 1000 cu ft of dissociated gas. With other utilities added in, the total cost is approximately $1.10 per 1000 cu ft.

Applications of dissociated ammonia—In the field of continuous galvanizing, dissociated ammonia is used as one of the basic atmospheres in the galvanizing line furnace. Because of its strongly deoxidizing properties, even in the short time required in the furnace, the hydrogen removes surface oxides, forming water vapor. This water vapor, in turn, picks up surface carbon. The reactions may be expressed in simplified form as follows:

$$FeO + H_2 \rightleftarrows Fe + H_2O$$

$$2H_2 + C \rightleftarrows CO_2 + 2H_2$$

Because of the potential hazards involved in the use of dissociated ammonia in a continuous furnace of any appreciable size, NX gas is generally made available both as a diluent and for furnace purging.

Dissociated ammonia and NX gas mixtures are also being used in continuous furnaces for high temperature annealing of silicon steel.

Stainless steel is being bright annealed in an atmosphere of dissociated ammonia. Measures are taken to reduce to an absolute minimum air and water vapor infiltration to the furnace, since chromium is so readily oxidized at the high temperatures required for annealing stainless steels.

By-product nitrogen—With the advent of low purity oxygen plants which are being installed by steel mills to provide oxygenated air for the blast furnace and open hearth, large quantities of by-product nitrogen may become available. Since nitrogen is the chief constituent of nearly all prepared atmospheres in modern steel mill use, the question arises as to how to employ this otherwise waste gas economically.

By-product nitrogen contains a considerable and often variable percentage of free oxygen. As obtained from the oxygen plant, it would be a highly oxidizing atmosphere if used in an annealing furnace. The obvious procedure to make the gas usable is to react out the oxygen with an excess of hydrogen to produce a nitrogen-hydrogen gas. When suitably dehydrated, the mixture constitutes a useful protective atmosphere. However, there are important technical and economic considerations to be met in this apparently straightforward process.

From the technical point of view, whatever apparatus may be employed to react out the oxygen must be sensitive to changes in the amount of oxygen in the by-product nitrogen. This problem does not appear too difficult but its solution will depend on the amount and rate of variation in the percentage of oxygen.

The average percentage of oxygen in the nitrogen, together with the desired final hydrogen percentage, are the determining factors for economic consideration, together with the cost of producing the hydrogen gas for the oxygen elimination. An approximate economic evaluation may be presented using dissociated ammonia as the source of hydrogen. Assuming the previously mentioned cost of $1.10 per 1000 cu ft of dissociated ammonia gas, 1000 cu ft of finished gas containing 95 per cent nitrogen and 5 per cent hydrogen may be produced for approximately 12 cents. This figure is based on a tank-car ammonia price of 4¢ per pound and the assumption that the by-product nitrogen contains 2.0 per cent oxygen. This 12¢ per 1000 cu ft of gas represents only the cost for the dissociated ammonia. For each additional per cent of oxygen in the nitrogen, or for each additional two per cent of hydrogen in the finished gas, this latter figure increases approximately 3½¢ per 1000 cu ft of finished gas. In this analysis, no charge is made for utilities or materials other than the dissociated ammonia which might be required for the process.

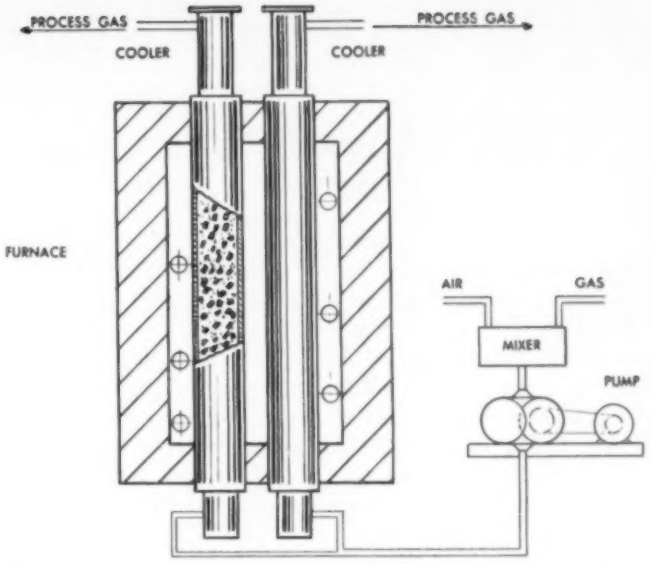


Figure 8 — Schematic diagram of RX atmosphere generator.

The extent to which by-product nitrogen will be used to make a protective atmosphere will probably depend largely on the extent of installation of oxygen plants at the mills, and on the composition and reliability of the by-product gas. At the present time one mill which is located adjacent to a commercial oxygen plant is obtaining by-product nitrogen and treating it with dissociated ammonia to produce an annealing atmosphere. The oxygen is being reacted out by a low temperature catalytic process. Other methods of reaction and other sources of hydrogen gas could be employed.

OTHER ATMOSPHERES

For a number of years, a high nitrogen, low hydrogen prepared atmosphere gas containing a small percentage of CO has been produced from natural gas and air by a process somewhat related to that used to make HNX gas. This high nitrogen gas is being used today in a number of plants producing rod, wire and specialty strip products.

A low temperature catalytic process has been recently developed for effective combustion of anhydrous ammonia and air, producing an end gas of nitrogen and hydrogen with an analysis adjustable between approximately 98 per cent N_2 and 2 per cent H_2 to 70 per cent N_2 and 30 per cent H_2. The process consists in mixing anhydrous ammonia and air in proportions necessary to produce the desired finished gas analysis, passing the

mixture through a catalyst bed and dehydrating to a low dewpoint. This gas is currently being put into commercial practice for treating certain specialty strip (razor blade stock). With ammonia at 4¢ per pound, the ammonia cost to produce a gas of 90 per cent N_2 and 10 per cent H_2 is approximately 60¢ per 1000 cu ft. The cost increases proportionally as the H_2 percentage is increased.

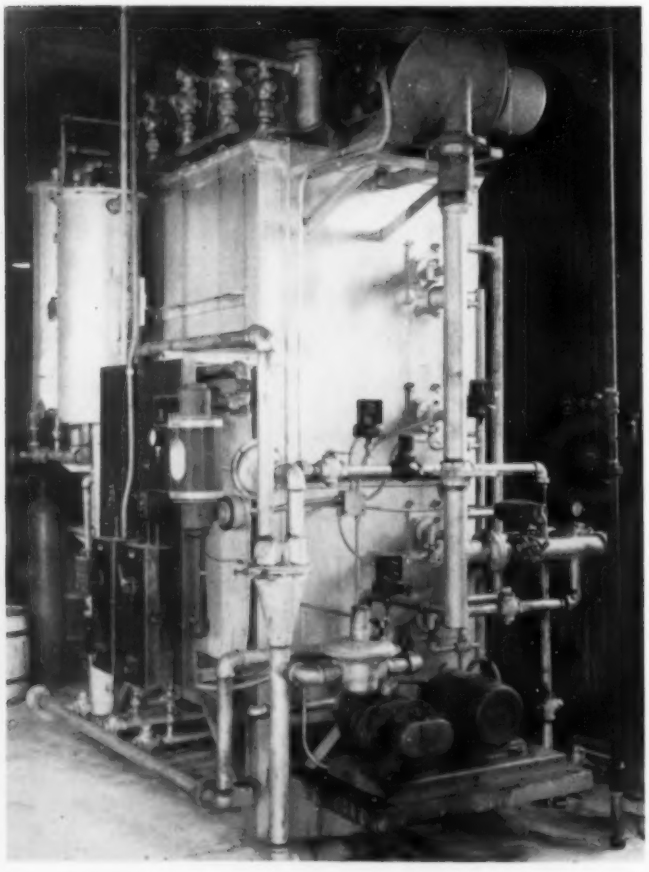
An atmosphere containing a percentage of hydrogen chloride gas produced by combusting natural gas, air and chlorine has been in commercial use for a number of years. This atmosphere is used as a processing step in the production of extremely tight galvanized coatings in a continuous galvanizing line. The HC1 gas reacts with surface oxides on the steel to produce volatile chlorides of iron which leave the furnace as a vapor. This process is known as "dry pickling." This furnace atmosphere thus constitutes an extremely active pickling agent.

An illustration of the corrective role which prepared atmospheres can play in steel mill operations is presented by the "carbon correction" process. By utilizing NX gas as a carrier and enriching it with a suitable amount of a carbon-containing gas such as natural gas, the carbon potential of the annealing atmosphere can be adjusted to control the surface carbon content of the stock being annealed. This process has been applied by one mill for restoring the surface carbon content of hot-rolled bars to the same value as the carbon content of the core. By this means, the costly operation of centerless grinding to remove decarburization is entirely eliminated, and a bar having uniform carbon content across its section is supplied to the customer. If desired, the surface carbon content may be increased to a value several points above that of the core.

Radiant tube-fired furnaces are employed for this carbon correction. Approximately 3 to 4 per cent of natural gas is added to the NX gas atmosphere. Annealing temperatures on the order of 1550 F are used with controlled cooling rates to 1000 F. Considerable quantities of both carbon and alloy steels are now being processed in this manner.

RX gas, see Figures 8 and 9, produced by the catalytic cracking of a non-combustible mixture of air and a hydrocarbon gas at high temperature, is also used for carbon correction. The carbon potential of the RX gas is maintained at the appropriate value by controlling its dewpoint. For carbon correction RX gas may be used alone or in mixtures with NX gas. RX gas, with suitable enrichments, is extensively employed in heat treating shops for gas carburizing, dry cyaniding and other case hardening processes.

Figure 9 — About 3600 cfhr of RX gas can be produced on this generator for carbon restoration atmospheres.



CONCLUSION

The number of types of prepared atmospheres and their fields of application in the steel mill are constantly expanding. Research and development work by equipment manufacturers, as well as mill operators, are bringing new gas mixtures into play as tools for the improvement of the quality of the steel supplied to the customer. For convenient reference, typical values for the constituents in the various prepared atmospheres are listed in Table I.

TABLE I
TYPICAL COMPOSITIONS OF PREPARED GAS ATMOSPHERES

Type of gas	Gas constituents — Per cent by volume					
	CO_2	CO	H_2	CH_4	H_2O	N_2
DX gas	5.0	10.5	12.5	0.5	0.8	70.7
NX gas	0.1	1.5	1.2	0.0	0.0	97.2
HNX gas	0.05	0.05	5.0	0.0	0.0	94.9
RX gas	0.0	20.7	38.7	0.8	0.0	39.8
AX gas	0.0	0.0	75.0	0.0	0.0	25.0
Hydrogenated by-product nitrogen	0.0	0.0	5.0	0.0	0.0	95.0

Atmospheres, while designed in most cases for the prevention of the surface deterioration of the steel stock during the annealing process, are also capable of rectifying the detrimental effects of previous processing. This improvement can take the form of correction of the surface oxidation or decarburization. Prepared furnace atmospheres should thus be considered by the operator as definite processing agents for improving the quality of his product, rather than passive agents to prevent the stock from being "burned up" in the annealing furnace.

POWER SUPPLY AND ELECTRICAL FEATURES

of Sparrows Point 68-in. Hot Strip Mill

By F. O. SCHNURE
Electrical Superintendent
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . a number of unique electrical details are incorporated in the 68-in. hot strip mill constructed at Sparrows Point . . . .

▲ THE construction program that covered the 68-in. hot strip mill included among other steel-making facilities, a blast furnace which produces as a by-product, large quantities of gas. Since the supply of blast furnace gas was already greater than the use, the logical step was to build a power generating plant to make efficient use of the vast additional quantities of this by-product fuel. Engineering studies indicated two standard 30,000-kw, 60-cycle, 850-psi, 900 F total temperature turbo-generators to represent the type and capacity that could best support the existing combination of generating and purchased power sources in serving the increased load. This station was erected east of the blast furnace plant and is known as Pennwood. Complete sources of power now are:

Six 25-cycle gas-electric generator units	18,000 kw
Two 25-cycle turbo-generator units	30,000 kw
25-cycle purchased power capacity	37,500 kw
25/60 cycle frequency changer, 20,000 kw 60-cycle purchased power capacity	75,000 kw
Two 60-cycle turbo-generator units	66,000 kw
	226,500 kw

While the 68-in. hot strip mill and Pennwood were authorized at the same time, the mill had been partially engineered but the power plant had not. The problem then was how to operate the mill during the interval between the completion of the two plants, which at first appeared to be several months, but which actually was a year.

The plant, prior to the expansion involving the 68-in. mill, required 140,000 kw of the then existing capacity. The proposed 68-in. mill was estimated to require from 30,000 to 40,000 kw, and this generally represents the actual requirements except when rolling maximum widths, when the peaks may reach 48,000 kw. Allowing for some diversity, it was agreed the 60-cycle purchased power supply from the Baltimore utility, consisting of two 34.5-kv, 500,000-cir mils circuits, could be increased to 90,000-kw peak capacity by adding to the capacity of the submarine cables comprising 0.8 miles of the three-mile line. Although at times, to keep from overloading the circuits, it was necessary to slow down the rate of rolling in one of the hot strip mills, the large proportion of regulated synchronous equipment in the mills helped maintain voltage and thereby made it possible to transmit hourly loads in excess of 70,000 kw with peaks over 100,000 kw.

Pennwood's capacity at present consists of two 30,000/33,000-kw, 0.85/0.83 power factor, 13.8-kv, 60-cycle, 0.5/15-psi hydrogen cooled generators, each direct-connected to a 37,500-kva, 13.8/34.5-kv, 3-phase, OISC transformer. Each generator is also directly connected to a 3,750-kva, 13.8/2.3-kv, 3-phase transformer which serves all the auxiliaries, either at 2,300 volts or through transformers at 440 volts, that are concerned with the turbo-generator and its boiler. The turbo-generator has a maximum rating of 39,780 kva with 15 psi of hydrogen, and here again the regulated synchronous equipment comprising the load will permit operation of the generator at near unity power factor and therefore at practically the same rating in kw.

Two 750,000-cir mils circuits on galvanized steel tow-

Figure 1 — Photograph of model of Pennwood Power Station.

Figure 2 — Sixty-cycle system control room in Pennwood Power Station.

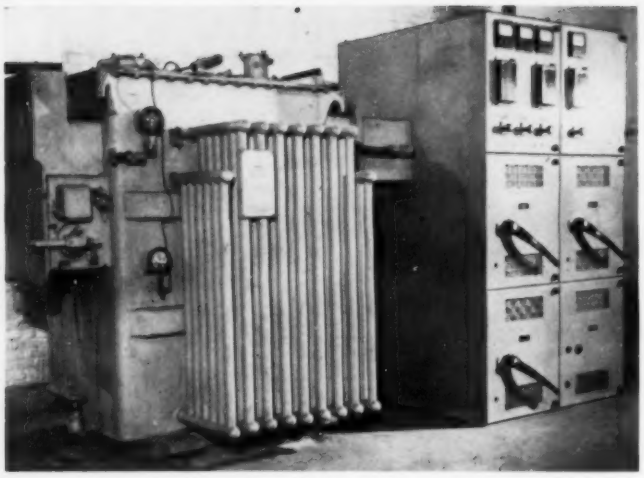
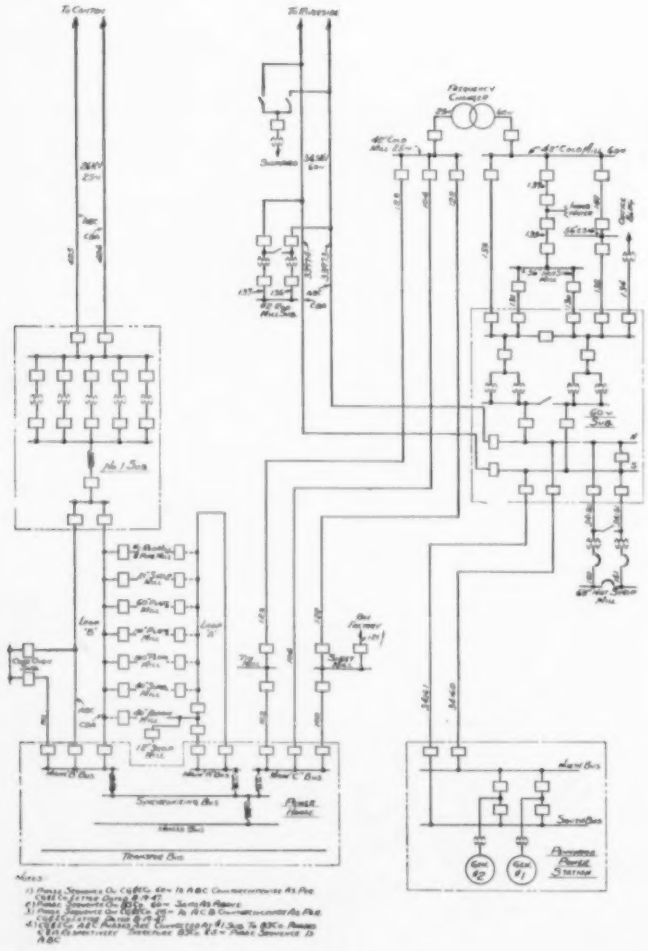


Figure 4 — Sixty-cycle tin and sheet substation.

ers, on from 400 to 500-ft spacing, connect Pennwood to the heart of the 60-cycle load which is at the tin and sheet 60-cycle substation, about a mile north of Pennwood. This is also the terminus of the Baltimore utility's circuits.

In 1936 when 60-cycle service was inaugurated in this plant, this substation was remotely controlled from the 42-in. cold mill, about a quarter of a mile distant. Situations arose many times that required manual attention that had to await the arrival of personnel from the power house. Since the two circuits from Pennwood really represent an extension of the 34.5-kv bus, supervisory control of the circuit breakers to the various load centers was installed. The Pennwood operator, through a 40-conductor control cable and the aid of approximately 250 relays receives load and circuit information and is also able to synchronize the various circuits. The last feature is quite important since power is present through three sources, Pennwood, Baltimore, and through the frequency changer from the 25-cycle system. Indication of the various loads on both the 25 and the 60-cycle systems are telemetered to Pennwood and there recorded for operating and billing purposes.

Figure 3 — One line diagram of 25 and 60-cycle power system.



Modern high speed protective relaying is installed. The Pennwood turbo-generators are protected by high speed differential relays while the generator-transformer combinations have percentage differential protection. All 34.5 and 6.9-kv buses as well as the transmission lines have overlapping differential protection. Back-up overload protection is used on all circuits as well as on the generators. Impedance relays are used on the section feeding the 68-in. hot strip mill. All transformers for stepping the 34.5-kv down to the utilization voltage of 6.9 kv are percentage differentially protected. Ground fault currents on 6.9-kv system are limited in all cases by means of a resistor or resistor-reactor combination connected from neutral of the transformers to ground. The 34.5-kv circuit breakers on the system are of the 1200-amp, 1,500,000-kva interrupting capacity, pneumatically closed, solenoid-tripped type while the 6.9-kv breakers are 7.5 and 15-kv, 1200 or 2000-amp, 500,000-kva solenoid-operated type. All circuit breakers and disconnecting switches are interlocked for safety considerations.

The 68-in. hot strip mill receives 34.5-kv power from the 60-cycle substation over two 500,000-cir mils circuits about half a mile in length. They terminate at the mill in an outdoor transformer substation shown in Figure 5. Each circuit is connected to a 15,000/20,000-kva, 34.5/6.9-kv, 60-cycle, 3-phase OISC transformer. Two 750,000-cir mils circuits in parallel conduct the 6.9-kv from each transformer to the 68-in. motor room bus.

The 68-in. hot strip, 6.9-kv switch gear is of the air-brake type and is of conventional construction, as

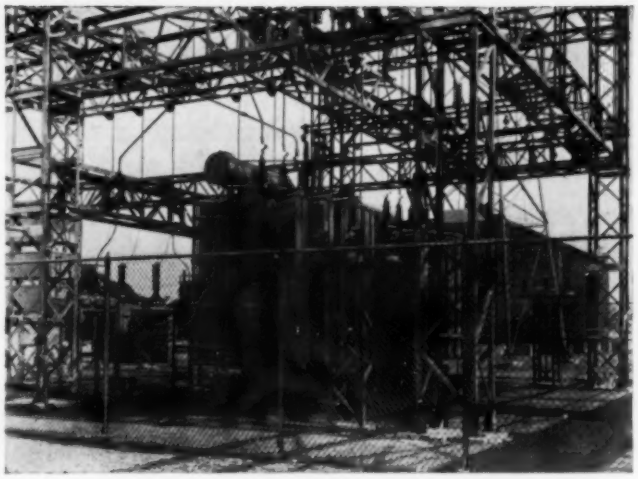


Figure 5 — Power for the new strip mill comes from an outdoor substation containing two 15,000-kva, 34.5/6.9 kv transformers.

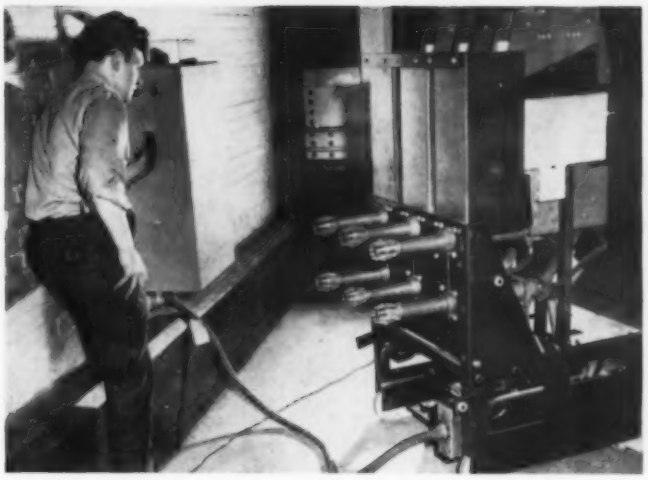


Figure 6 — Typical 6.9-kv circuit breaker.

shown on Figure 6. Each line circuit terminates on a section of the bus serving about 50 per cent of the load and the two sections are joined by a bus tie-breaker on which synchronizing equipment is provided. The power in both circuits is totalized in one graphic meter.

This mill, designed to roll slabs 6½ in. thick by 22 ft long and up to 61 in. wide, uses five roughing stands to reduce the slab to the conventional ¾ in. thickness for delivery to the finishing stands. The breakdown stands are powered by the following motors connected to reduction gears.

	Hp	Rpm	Gear ratio
Vertical edging scale breaker	800	514	200/7
No. 1 rougher	2,000	150	225/30
No. 2 rougher	3,500	144	218/37
No. 3 rougher	4,500	257	225/30
No. 4 rougher	4,500	400	225/30
No. 5 rougher	4,500	400	225/30

All of the above are synchronous motors designed for 0.8 power factor, 350 per cent pull-out torque and full-voltage starting. Experience with full-voltage starting and no means of positioning on an adjacent 56-in. hot strip mill had shown the desirability in order to save time when changing rolls, of providing a method of "spotting" the spade of the coupling in a vertical position. This is accomplished by changing the excitation of three small d-c generators inserted in the stator circuit, in a sequence so as to produce a revolving field in the stator winding of the synchronous motor. The excitation of the small generators is controlled by means of a motor-operated field rheostat and the speed of inching is also governed by the speed at which this device is operated. Previous experience had shown that an average of 15 to 20 "starts," requiring several minutes, was necessary to position a roll. This device will do the job in about a minute.

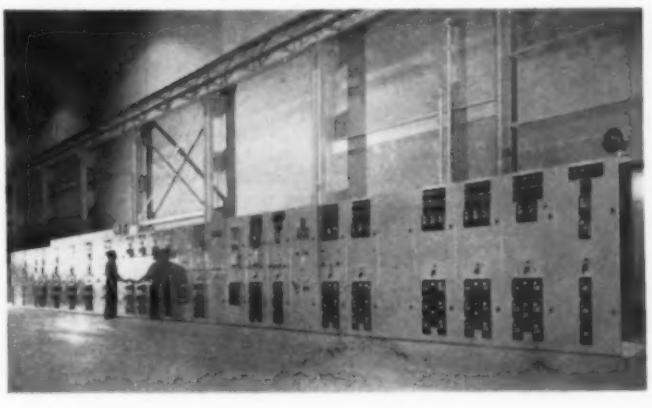
The first two finishing stands are geared, and of the other four, which are direct-connected, three are driven by 4000-hp and the fourth by a 3500-hp adjustable speed motor. Three 6000-kw motor-generator sets supply 600-volt power. Automatic voltage regulation is provided.

The ventilating and cooling system for the main equipment is of the re-circulating type with enough capacity in the make-up fans and air-cleaning system to augment the air coolers should the water used for cooling go above the 85 F for which the coolers were designed. Four 100,000-cfm blowers, one located at each end of a tunnel, which is a part of the two rows of foundations for the finishing motors and for the motor-generator sets, draw air from the d-c motors or the generators and discharge it through a surface air cooler to the motor room. The rougher motors are equipped with the same type of system except that each motor is totally enclosed and has individual air cooler and blower. The water passing through the coolers is the make-up supply to the mill spray, cooling, and hydraulic systems.

The make-up air is cleaned by a 150,000-cfm capacity electrostatic cleaner provided with two automatic washers on each side of the filter. Hot water is provided for the washers. The ventilating equipment and the circuit breakers for the d-c equipment are located in the basement.

Most of the auxiliary control for the mill and the furnaces is located in the motor room, which is 65 x 800 ft; the control for the oil system is in the oil cellar adjacent to it; for the water system, on the mill floor above the pumps, and for the shearing and trimming lines in the basement control rooms.

Figure 7 — Switchboard for mill.



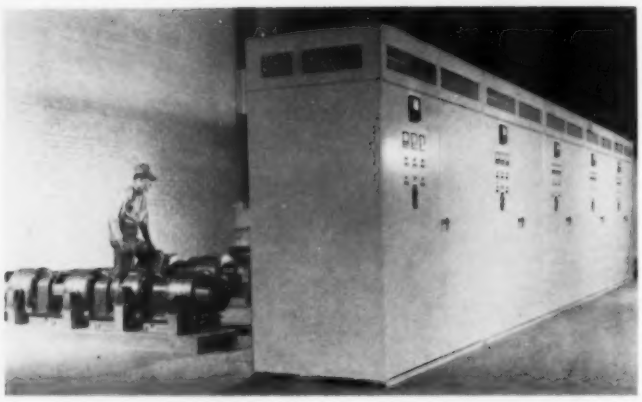
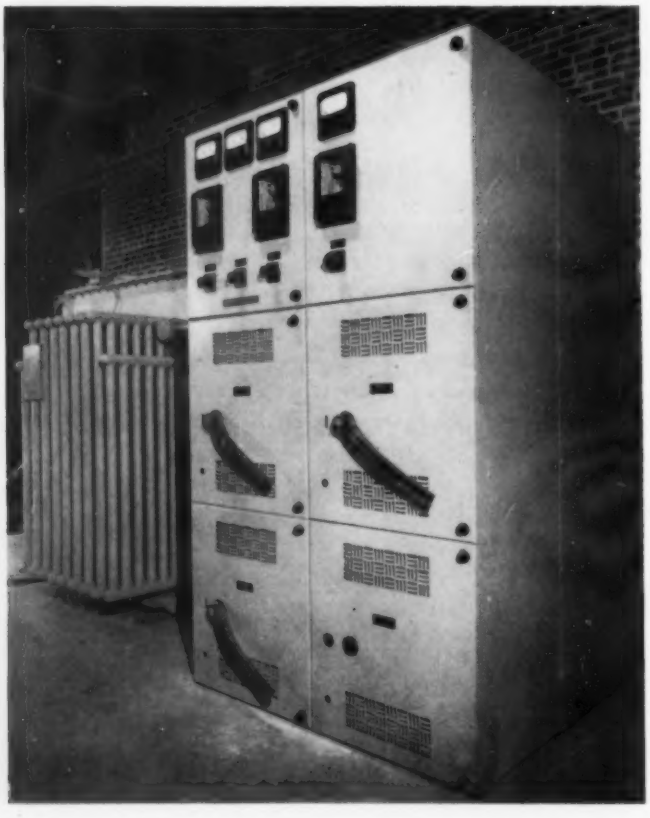


Figure 8 — Inching, dynamic-braking and field application control for roughing motors of the 68-in. hot strip mill.

This mill, from the furnaces to the coilers, is about 1100 ft long. It is a requirement brought about by the 6½-in. thickness and the 22-ft length of the slab and the fact that the slab after each roughing pass must lie free on the table. The length of the mill, therefore, is a factor that determines the type of auxiliary power-distribution system to be used; 440-v, 3-phase, 60-cycle power is distributed at 6.9-kv to 750-kva, 7.2/0.48-kv load centers located at strategic points throughout the mill. Ten load centers are fed by three-conductor cable from two circuits, one from the south, the other from the north section of the 6.9-kv bus. Some load centers are served by a single transformer with a tie line to another center while others have a transformer at each end. This does provide a measure of spare capacity in an emergency and requires only one 750-kva transformer as a spare. Three-conductor, 250,000-cir mils, 13.2-kv, varnished cambric cable with armor protection is used for 6.9-kv distribution. The secondary circuit breakers are of the draw-out type, 50,000-amp interrupting capacity. A typical 440-v load center is shown in Figure 9.

Figure 9 — Load center shown is 750 kva.



The metal clad 6.9-kv switch gear consists of 33 sections comprised of six auxiliary sections and 27 sections with removable circuit-breaker units. The circuit breakers are of the air-brake type, 7500-v, 1200-amp and have an interrupting capacity of 500,000 kva.

Two 750-kw, 250-v mercury arc rectifiers supply direct current power for the cranes and mill auxiliaries. One 3-phase, non-flammable, oil-filled transformer serves the two rectifiers. The switch gear consists of one air circuit breaker and two knife switches per rectifier section, five sets of 4000-amp feeder equipment and one 8000-amp tie feeder section. These panels are all equipped with semi-high speed, automatic reclosing air circuit breakers and have an interrupting capacity of 150,000 amp.

Figure 10 — The runout table is controlled in three sections.

The mill tables from the furnace to the finishing mills are of the conventional line-shaft design and are driven by mill-type motors. The delay table between the last rougher and the finishing mills consists of three sections, each driven by a 50-hp, shunt-wound motor. Power is supplied from a 200-kw motor-generator by variable-voltage control. This allows matching the speed of the table with that of the steel leaving the last rougher, and also that of the steel entering the first finishing stand as well as providing a "delaying speed" should metallurgical conditions so require.

The flying shear in this mill differs from the usual

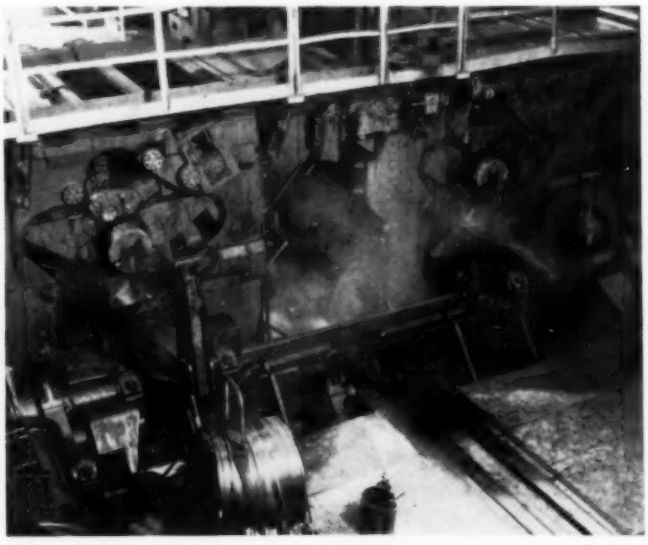
twin-mill type, motor-geared application in that it is directly driven by one motor, which, in this case, is rated 900 hp, 600-v, 300-rpm and has an armature of very small diameter. Low inertia is a requirement in order that the acceleration will be fast. This characteristic allows a load relay on the second finishing stand ahead of the shear, instead of on the third or fourth, to provide the starting intelligence, a feature that produces more accurate cropping. A 750-kw, motor-generator set supplies power for the drive. The shear control is under an electronic regulator. The intelligence for synchronizing the speed of the shear with that of the last finishing stand is provided by two pilot generators, one geared to the final finishing stand and the other to the shear motor. The voltage output of these pilot generators is connected so they are in opposition to each other. They are in exact synchronism when the differential voltage is zero. Suitable regulators are provided to recalibrate the output voltages of the pilot generators for the various diameter of rolls and to cover the range of cut lengths. The shear and its various components have been described in a paper by J. Raymond Erbe, in his paper "Improved Flying Shear Drive," Proceedings of the Association of Iron and Steel Engineers, 1949, p 205.

Beyond the finishing mills the strip is delivered to the coilers by 237 rolls each driven by a 4-hp, d-c, shunt-wound 75 C motor. This table is controlled in three sections, each powered by a 300-kw generator, three of which, along with a 1250-hp motor, comprise the motor-generator set. Another such set provides generators for the two coilers or for the three sections of table, consisting of 164 rolls, leading from the coilers to the pilers.

Each down-coiler consists of four pairs of rolls and one single roll driven by five 20-hp, shunt-wound 75 C, bracket-mounted motors. A heavy pinch roll driven by a 35-hp, shunt-wound mill-type motor precedes each coiler.

The coils are delivered to a depressed conveyor system consisting of twelve sections, each driven by a 35-hp, shunt-wound mill-type motor. This system delivers

Figure 11 — Coils are delivered from the coilers to a depressed conveyor system.



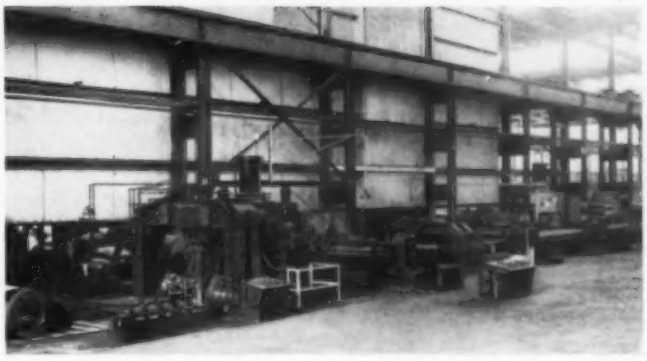
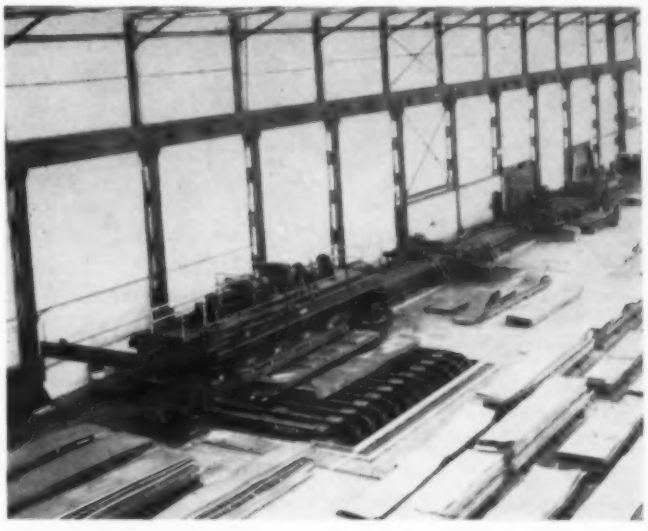


Figure 12 — Hot mill coils are processed on two trimming and shearing lines consisting of a processor, pinch roll, side trimmer and shear.

Figure 13 — Sheared strip is fed into the shearing and trimming line by a five-magnet, floor-operated crane.



the coils either to the coil-storage building common to both the 56-in. and 68-in. hot strip mills, or to the existing conveying system leading to the 56-in. cold sheet mill.

Hot mill coils are processed through two trimming and shearing lines consisting of processor, pinch roll, side trimmer and shear, all operated by variable voltage. The 300-kw motor-generator sets, with the various elements of control, are located in basement power and control room between the two lines.

Sheared material is processed by a $\frac{3}{16}$-in. side-trimming and shearing line operated from a constant potential bus. Sheared strip is fed into this line by a floor-operated crane using five magnets to handle the stock.

The mill can roll hourly tonnages of over 400- 8-hour turn tonnages over 2800, and 24-hour tonnages over 7000. The power required per ton of hot-rolled strip averages around 45 kwhr for the main drives, and 78 kwhr for the entire mill, which is about the same as the adjacent 56-in. hot strip mill. It would appear that this mill, because of the larger slabs, should have a lower kwhr rate per ton than the 56-in. mill; in fact, on days when high tonages are rolled, the overall kwhr drops to around 70. However, large quantities of water are used for cooling and descaling purposes, and the twenty-odd pumps motorized by an average of 175 hp account for the difference.

MAIN MILL DRIVES

for Sparrows Point 68-in. Hot Strip Mill

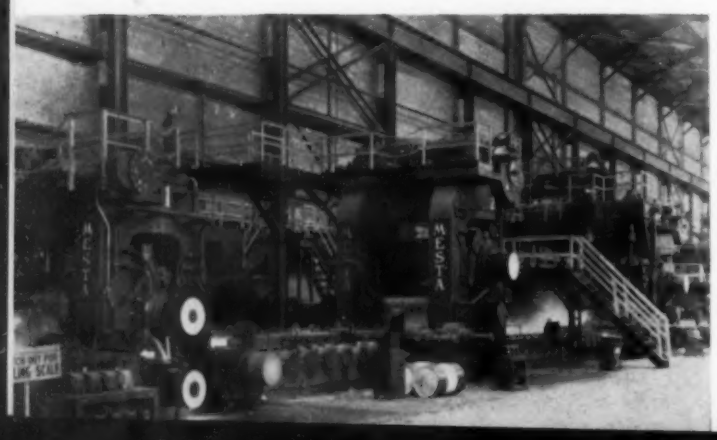
By H. W. BARTLING
Steel Mill Section
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

. . . . this paper supplements the previous one by F. O. Schnure . . . .

▲ THE information in this paper supplements the valuable data given in the previous paper by F. O Schnure, entitled "Power Supply and Electrical Features of Sparrows Point 68-in. Hot Strip Mill." The experience of the 56-in. hot strip mill helped the engineers of the Bethlehem Steel Co. to go ahead with the problems presented by the new contemplated 68-in. mill installation. The 56-in. mill rolls slabs approximately 4½ in. thick by 15 ft long, getting two slabs from each ingot. On the larger mill it was expected that one slab would be used per ingot, which would mean a piece approximately 6½ in. thick by 22 ft long or 450 lb per in. of width as against 225 lb per in. in width on the smaller mill. The widths contemplated vary from 20 to 61 in. Other limiting conditions were the maximum available ingot weight of 27,000 lb, the maximum length of 264 in. for slabs coming from the furnace and the lightest section to be rolled in the finished product of 18 gage material.

After careful consideration of all these conditions, it was decided that the conventional broadside mill would be eliminated and a 5-stand roughing train be used. With temperatures of around 2250 F for the slab coming from the furnace it was felt that the roughing train could reduce the slab from 6½ in. thick to 0.730 in. through the five stands of the roughing train. This would mean roughly that with the piece entering No. 1 stand 6½ in. thick, it would emerge approximately 5¼ in. thick. Out of No. 2 stand it would be approximately 3¼ in. thick; out of No. 3 stand approximately 2¼ in. thick; out of No. 4 stand approximately 1.375 in. thick, and out of No. 5 stand approximately 0.730 in. thick with the temperature 1900 F or higher. Carried on through the 6-stand finishing train, there would be thicknesses coming from stand No. 6 approximately 0.340 in. and from stand No. 7, 0.1957 in.; from No. 8, 0 140 in.; from No. 9, 0.075 in.; from No. 10, 0.063 in., and from No. 11, 0.047 or 18 gage material. This production will be delivered at approximately 1800 to 2000 fpm.

Figure 1 — The roughing stands of the 68-in. hot strip mill are driven by 2000, 3500, and 4500-hp synchronous motors.



On the 56-in. mill, a vertical edging roll was used ahead of the roughing train to correct irregularities and to remove the scale from the slabs. The slabs coming to this mill varied in widths in steps of 2 in. and the vertical edger was able to accurately control width for a final width up to approximately 50 in. On the larger mill, the accurate gaging of widths would not permit the edging operation as the edges built up too much, so the vertical edging rolls of the mill are being redesigned for a closed pass.

Data on the power system and power required by the expected rolling schedules led to the final conclusion that all stands of the roughing mill train could best be driven by synchronous units. For the larger machines, the existing 6600-volt circuit was adopted and on the smaller units, 440 volt auxiliary power was used. The scale breaking roll is driven by an 800-hp, 514-rpm synchronous motor geared to the stands. No. 1 mill is driven by a direct connected synchronous machine rated 2000 hp at 150 rpm. No. 2 stand is driven by a 3500-hp motor at 144 rpm. No. 3 stand is driven by a 4500-hp motor at 257 rpm, and each of stands 4 and 5 is driven by an individual 4500-hp, 400-rpm synchronous motor.

All of these machines carry the usual steel mill rating of 40 C operation and the 25 per cent 2-hour overload. The pull-out torque of each unit is 350 per cent of normal torque. All machines are full Class B insulated and are provided with thrust bearings. Because of the ex-

Figure 2 — Shown in the motor room of the 68-in. hot strip mill are the finishing stand motors at the left, the motor generator set at the right and the synchronous roughing stand motors in the background.

treme length of the roughing mill motor room, it was decided that the individual closed system of ventilation would best be adapted to all machines of the roughing train including the scale breaker motor. An air-to-water heat exchanger is mounted beneath the synchronous motor and the air is drawn from one side of the machine, forced through the cooler, and conducted back to the synchronous motor windings on the other side of the motor unit.

The experience of the 56-in. mill on the finishing train drive centered around the use of geared motors throughout. Because of the horsepowers contemplated in the 68-in. mill, consideration was given to the direct connection of the drives as against the double armature construction of higher speed motor units. Based upon expected mill practice and the economic balance of the problem, it was decided that stands No. 6 and 7 of the finishing train should be geared units with stands No. 8, 9, 10 and 11 of the direct connected type. The scale breaker motor is a 500-hp, d-c machine rated 150 to 600 rpm. Stands No. 6 and 7 are each driven by a 4000-hp, 125/250-rpm motor. Stand No. 8 is driven by a 4000-hp motor rated 80/160 rpm. Stand No. 9 is driven by a 4000-hp, 100/200-rpm motor. Stand No. 10 is driven by a 4000-hp, 125/250-rpm motor, and stand No. 11 is driven by 3500-hp, 150/300-rpm unit. Again all machines of the finishing mill train are full Class B insulated, and are equipped with thrust bearings whether geared or direct connected. The d-c motors of the finishing train are supported from three synchronous motor-generator sets, each set consisting of two 3000-kw generators driven by an 8400-hp, 360-rpm synchronous motor. Conforming with previous construction features, Class B insulation was used throughout on all machines and the individual, self contained recirculating system of ventilation was adopted for each of the 8400-hp, synchronous motors.

A separate auxiliary exciter set is used with a 250-kw, 250-volt constant potential exciter supplying excitation for the d-c motors and the synchronous machines of the roughing mill drive, together with other necessary control power. The 50-kw exciter is used for

Figure 3 — A 700-kw rectifier is controlled by each one of these control cubicles. Each rectifier has its own heat changer, disconnect switches, etc. but both are operated from common rectifier transformer.

the d-c generators supporting the machines of the finishing mill train. A separate 150-kw exciter is used for the synchronous motors to permit power factor regulation. This set is driven by a 700-hp, 1200-rpm synchronous motor. To get away from the use of 6600-v power in the smaller machines, the 700-hp driver of this exciter set and the 800-hp scale breaker of the roughing train are started across the line from the 440-v power circuit. The 700-hp synchronous motor also uses a self contained recirculating cooling system.

The compact nature of the finishing mill motor room permitted the use of a down-draft recirculating system of ventilation giving the decided advantage of a cool motor room. Accordingly the covers of all of the motors of the finishing mill train, the generators of the main supporting motor-generator sets, and the d-c units of the exciter set are designed for down-draft ventilation. The total heat to be absorbed in this cooling system approximated 2100-kw. In the normal installation of a closed recirculating system, approximately 10 per cent of the total air to be handled is brought in from the outside, cleaned and introduced into the air stream. Based upon previous experiences, the engineers of the Bethlehem organization decided that this volume of air should be increased materially. Accordingly, the main circulating system consists of four fan units, each capable of handling approximately 107,000 cu ft of air for the normal recirculation in the closed system. Adding to this stream of air are three fans each rated 57,600-cfm, drawing air from the outside through precipitron type cleaning units before introducing that air into the general system. These air cleaners are equipped with two automatic washers.

The power for the complete mill is transformed from the 34½-kv service through two banks of 3-phase transformers each rated 15,000 kva. These transformers are designed for future addition of forced air cooling which will increase the capacity to 20,000 kva for each bank. Secondary energy at 6900 v is carried to the motors of the supporting motor-generator sets, and to a 1500-kva rectifier unit which provides power for the mill supply circuit. This rectifier installation is a little unusual in that there are two 750-kw rectifiers operating from a single inert gas filled transformer. The power is transmitted through 4000-amp feeders with an 8000-amp tie feeder to another part of the mill.

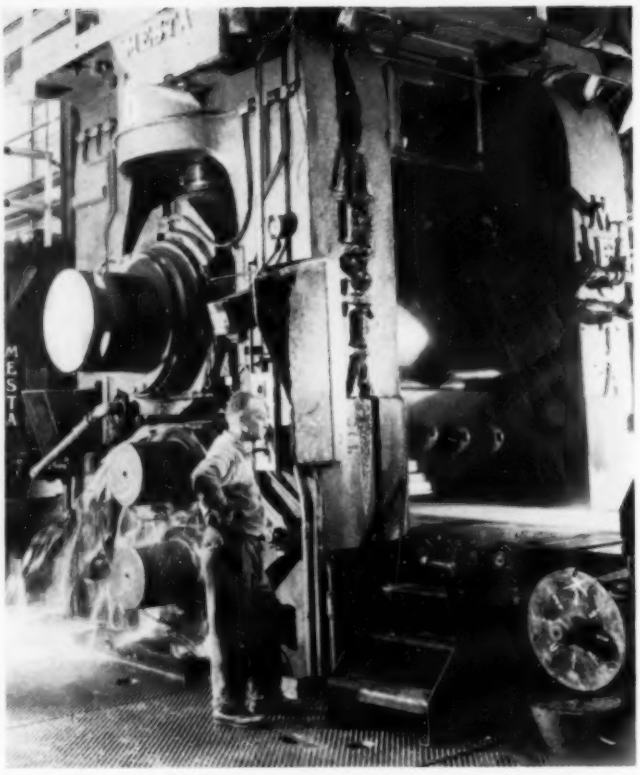


Figure 5 — The finishing stand is driven by a 4000-hp, d-c motor.

In the pulpit of the finishing mill train, there is the usual desk with its indicating instruments, including the fan type ammeters indicating individual motor load.

Departing from the general description of the mill and considering some of the specific characteristics of the control of this type of machinery, the across-the-line starting of the five main synchronous motor drives of the roughing mill train is accomplished through 6900-volt air-break switchgear. Mechanically interlocked with each mainline motor breaker and mounted in the same lineup is a three-pole isolating breaker used to connect the roughing motor to a d-c source for dynamic braking and jogging service. The motor field leads are brought into separate cubicals which contain the field application control equipment; the five cubicals comprising a separate lineup of secondary control

Figure 4 — Stationary enclosed type d-c switchgear is used for the two 750-kw, 250-v rectifiers.

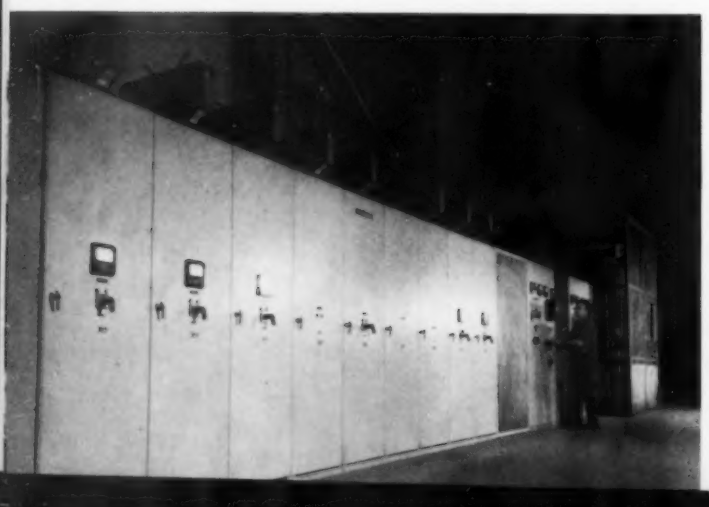
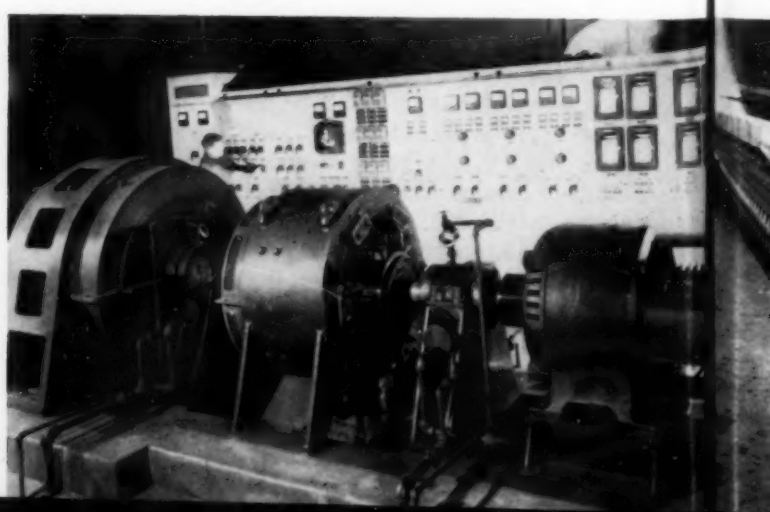


Figure 6 — The photograph shows the 450-kw main exciter set, and in the background can be seen the d-c control panel for the finishing train equipment.

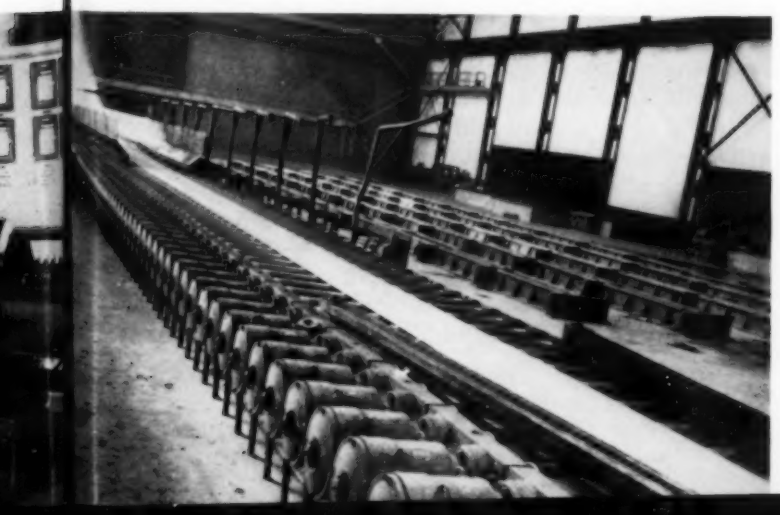


supplementing the main switchgear. Also in these same cubicals are the interlocking relays and contactors for the dynamic braking and jogging operations. As mentioned before, the roughing mill scale breaker is a 440-v drive operated through across-the-line starting equipment and controlled by pistol grip switches on the switchgear unit, and by dual station switches located on the roughing mill pulpit. This allows operation either by the pulpit operator or the motor room attendant. A selector switch on the switchgear allows the motor room attendant to cut out the pulpit starting control should he so desire. The synchronization and field application functions are entirely automatic. This same setup of switches is followed on the other stands of the roughing mill train.

A selector switch on the roughing mill pulpit desk controls the isolating breaker. In position 1, the selector switch indicates the normal running set-up which allows the main a-c breaker to be closed or tripped as desired. Tripping of the a-c line breaker automatically brings in the isolating switch for dynamic braking operations. In position 2 of the selector switch in the roughing mill pulpit, the isolating breaker is closed directly from that position for jogging operations. Complete interlocking in either position of the selector switch insures that no other operation is being attempted or is in progress before operation of the selector switch.

The motive power for the roughing motor jogging and dynamic braking operations is furnished by 4-unit motor generator set consisting of three 7½-kw exciters driven by a squirrel cage induction motor. One 7½ kw exciter feeds each phase of the synchronous motor stator connected in wye connection. Each 7½-kw unit is excited from a motor operated potentiometer rheostat having mounted thereon three pairs of brushes, 120 degrees apart. Each pair of brushes is connected to the field of a different exciter unit. This rheostat is so designed that a complete rotation results in a sine wave voltage from each exciter. The voltages of the exciter being in three-phase relation, an alternating 3-phase power is delivered to the synchronous motor stator at an adjustable frequency approximating one cycle per second. With the closing operation of the isolator breaker, the synchronous motor field is automatically applied and with the alternating 3-phase power delivered to the motor stator, the synchronous machine will rotate at reduced speed corresponding to the frequency applied: which in turn is a function of the speed of the motor operated rheostat. For reverse operation it is only necessary to change the direction of rotation of the motor operated rheostat. For reverse operation it is only necessary to change the direction of rotation of the motor ting the roll in any position desired.

Figure 7 — Runout tables for 68-in. hot strip mill.



Control of the direct current motors of the finishing train is accomplished with the Ward-Leonard system of control common to most continuous hot strip mills with motor speed variation accomplished by main and vernier rheostats operated from the pulpit. A pedestal mounted circuit breaker of 250,000-amp interrupting capacity is placed in the positive and negative line of each generator and motor. These breakers are mounted at the basement level beside the machine foundations to permit the most economical construction of the mill bus. Such auxiliaries as the main motor and generator field rheostats, the dynamic braking contactors and the circuit breaker of the distribution panel of the main exciter are mounted in this main bus alley.

On the main mill floor, a duplex dead-front control panel mounts the finishing train metering and control switching, providing a motor room central control and annunciator station. The rear section of the duplex board carries the important mill interlocking control relays together with the main mill motor operated field rheostats.

To insure clearing the main air circuit breakers in the shortest possible time, a special flash-over and fault predicting circuit is used. This circuit energizes a low inductance trip coil on the breakers and operates as a function of violent current swings. Final breaker characteristics are adjusted in the field to suit mill loads.

The excitation for the six generators of the hot mill is supplied from the 50-kw exciter on the main exciter set, this unit being under the control of a rotating regulator providing voltage regulation for the main bus. For variable voltage operation, the rotating voltage regulator is recalibrated by the mill motor operated rheostat, operated manually from the pulpit, or the motor room control or operated automatically by a mill voltage setting circuit. In cases of emergency the rotating regulator exciter can be cut out and the main generator exciter controlled directly from its own rheostat. Load division between the six generators is provided by a low voltage, low current winding in each generator connected to the negative brush of each machine, and a common equalizing bus. The difference in IR drop from the negative brush of the generator to the negative bus provides a circulating current through the equalizing winding which drops the voltage of the machine with the higher electro-motive force, and raises the voltage of the machine with the lower electro-motive force. Experience with this circuit has indicated that load balance can be maintained within approximately 100 amp on machines of this rating.

The common excitation circuit obtaining energy from the 250-kw machine of the main exciter set is under control of a rocking contact type voltage regulator, insuring constant potential being applied to the finishing mill motors, etc. In emergency operation, the entire exciter load may be transferred to the mill supply circuit.

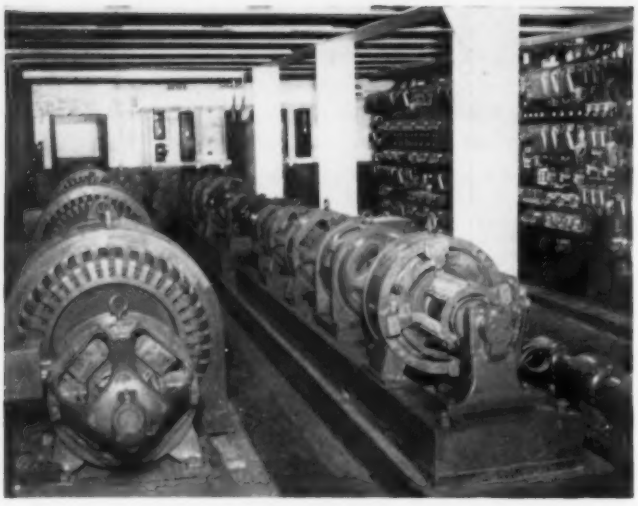


Figure 8—Control room for mill is located in the basement.

The third machine of the main exciter set supplies excitation for the three 8400-hp synchronous motors of the finishing mill motor generator sets. It is normally under control of a power factor regulator but can be operated from the mill supply circuit under hand control.

The finishing mill control permits closing of the generator circuit breakers from the pulpit only. The motor room control is provided with a permissive switch which can de-energize the pulpit control, confining all activities to the motor room. Both the pulpit and the motor room are provided with emergency stop switches.

Control of the motor speeds of the finishing train is confined to the pulpit operator, and fine speed adjustment is obtained through the hand operated field vernier rheostat, which rheostat has a range of plus or minus 10 per cent of base motor speed.

The overall control is completely interlocked so that the ventilating equipment must be in operation, the space heaters must be turned off, the exciter set must be at full voltage, and the main generator and motor circuit breakers open before the main 6600-v breakers to the synchronous motors of the sets can be closed. The interlocking further provides indication through the annunciator system for any difficulties which may come up during the operating cycle.

With the starting operation of the mill in the hands of operators whose experience was confined to the use of finishing mill motors geared to the mill, it was expected some difficulty would be encountered in this mill which is a combination of direct connected and geared drives. There was difficulty at the start, but the operators soon became accustomed to the new arrangement, and set out to produce records on this mill. This is substantiated by the fact that a single turn can produce as much as 2800 tons, and three consecutive shifts can produce 7000 tons with the power requirements indicated in Mr. Schnure's paper.

DISCUSSION

PRESENTED BY

W. E. GRAINGER, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

F. W. CRAMER, Consulting Engineer, Elliott Co., Pittsburgh, Pa.

H. W. BARTLING, Steel Mill Section, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

W. E. Grainger: I appreciate having the opportunity of listening to this discussion on the electrical equipment for this mill because, as has been indicated, this hot strip mill is doing a job as good as any in the country.

As far as the tonnage records are concerned, the authors have been talking about 400 tons per hour, I do not believe that is the standard measure of production. In January we did on this mill 260-some tons per hour for the month. Last month, however, we were down to 250 tons as an average for the tons per hour for the month; but that is very good production and, so far as the performance of the mill is concerned, we are quite well pleased with it.

We have had difficulties, both mechanical and electrical, in getting these tonnages, but I do not believe the average tonnage of 260 tons per hour is our top. When I am talking about 260 tons per hour I mean the production during the time the mill is supposed to be operating.

F. W. Cramer: Mr. Grainger's remarks on average tons produced by a mill should be of interest to all producers. This is a true measure of mill capacity rather than record hours, turns, or days.

One strip mill has recently installed additional heating furnaces and coilers of the existing mill and has rolled over 8500 tons in 24 hours. This is an example of a daily record rather than an average tonnage.

Mr. Schnure commented on the additional power requirements resulting from these new installations. In addition to the new demand peaks, he will find that the load factor of his system is also higher.

This latest of the hot strip mill installations has a top speed no greater than several of the mills installed ten years ago. It does, however, have better slab heating facilities, better coilers, uses longer and thicker slabs; all of which assist in keeping the mill full of product and results in more tons per hour of product than the earlier mills.

On the cold reduction mills, the average weight of coil has increased to some 35,000 lb. This fact results in longer rolling cycles and fewer slowdowns for threading new coils, hence more production. It also raises the load factor of the power system.

The reference to the high peaks on the system is typical of conditions on many of the utility and industrial systems. Many of these attempt to absorb all the load possible and either drop frequency or voltage to cushion the peaks. For this reason many industrial systems in particular do not know what their short-time peaks are and will not know until additional generation is available.

Determination of Size

OF ELECTRICAL EQUIPMENT

By GEORGE SCHEER
Chief Consulting Electrical Engineer
Kaiser Engineers
Oakland, Calif.

. . . . curves and equivalent time are used as tools to determine thermal capacity of electrical equipment . . . .

▲ TWO factors determine the capacity of electrical equipment. One factor is its ability to dissipate the heat generated and keep its temperature within prescribed limits. The other factor is its ability to function for a short period of time under its maximum condition of loading. This second factor may be two to three times as great as the thermal limit. Although it may be of equal importance in determining the size of equipment required, this momentary overload is not considered in this article; only the thermal capacity is considered.

Heating in electrical equipment is essentially proportional to the I^2R loss or to the square of its output. To determine the thermal capacity required for electrical equipment, the root mean square law is used. With a rectifier or generator, the current is usually proportional to the kw so that the capacity is worked out in terms of kw; with a transformer, kva is used as the comparable unit; with an a-c motor or with a d-c motor controlled by field weakening, hp is the unit used; and with a reversing mill motor, torque is used.

Regardless of whether hp, kw, kva or torque is used as the comparable unit, to determine the rms value the time of duration for each different value of load during a cycle of operation is determined. The square of each value of load is multiplied by its time of duration; all of the resultants are added, the total is divided by the time of the cycle, and the square root of the result is the rms value, which is the equivalent thermal hp, kw, kva or torque required.

Mathematically the solution of the rms is very simple. There are, however, two difficulties: first, it is very tedious and is subject to errors, particularly that of decimal point, and secondly, the person making the calculations loses perception of the work throughout the calculation.

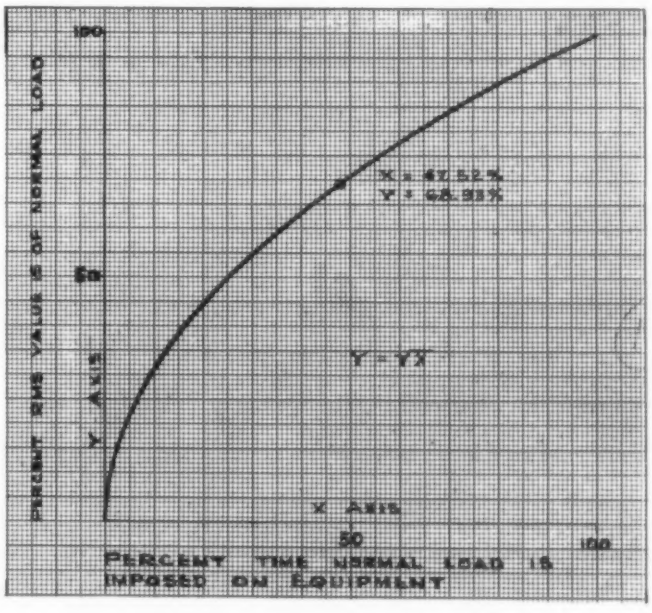
It is possible, however, to obtain the solution using very simple curves, to obtain any required degree of accuracy, and to retain perception of the work at all times.

If a motor operates at its normal load but 50 per cent of the time and is off 50 per cent of the time, it will have the same temperature rise as if it had operated 70.7 per cent of normal load all of the time. This can be shown as follows:

Square of load	×	Time	=	
1^2	×	0.5	=	0.5
0	×	0.5	=	0.00
$(.707)^2$	×	1.0		0.5

Similarly, if the motor carries normal load 25 per

Figure 1 — The curve gives the ratio between the time that the normal load is imposed on the equipment and the root-mean-square value of the normal load.



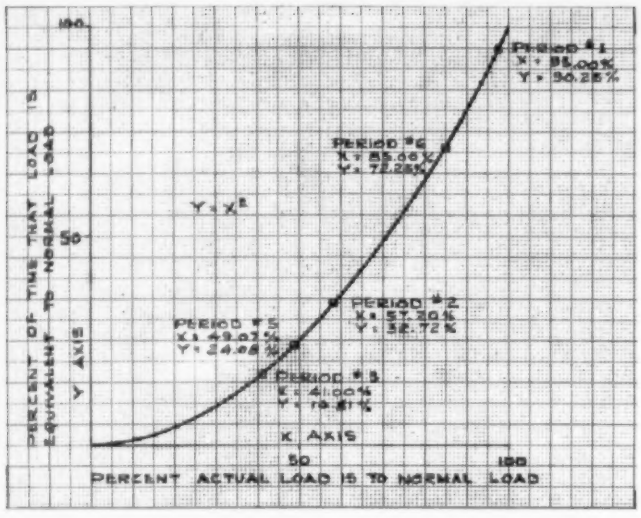


Figure 2 — This curve is used to convert any load into its equivalent time of normal load.

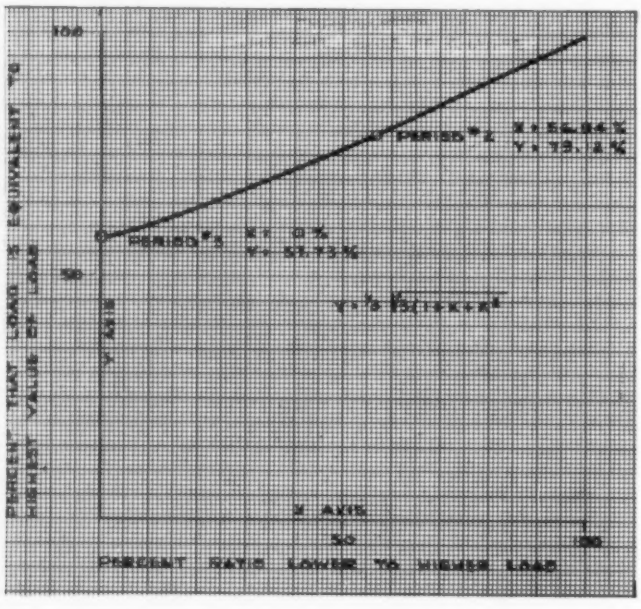
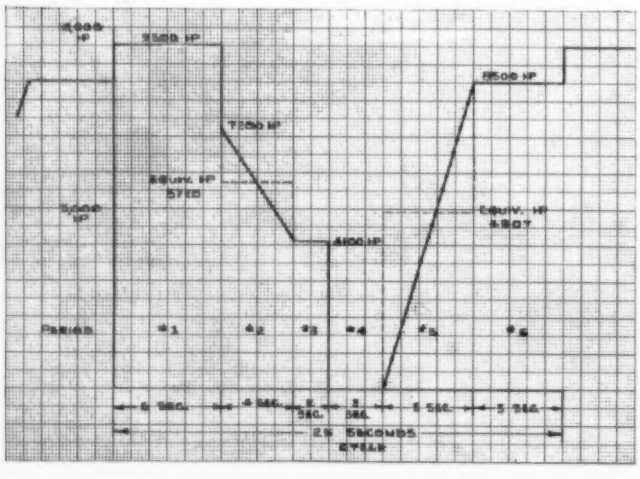


Figure 3 — This curve is used to transform a load changing at a constant rate to an equivalent load.

Figure 4 — Sample load cycle on 10,000-hp motor used for typical calculation.



cent of the time only and is off the other 75 per cent, the rms value is 50 per cent of normal load.

This relation is shown for all values by Figure 1. To use this curve, it is necessary that the time involved be converted from its actual time in seconds to its percentage of the operating cycle time. The load is expressed as a percentage of normal load.

In many cases the equipment will operate at more than one different value of load during a cycle. To use Figure 1, it is necessary that the heating effect of each different load be converted into its equivalent time for operation at normal load. The term normal load as used here is purely arbitrary, and any one of the load values can be used as normal, or a figure such as 1,000 or 10,000 can be used.

To convert any load into its equivalent time of normal load, Figure 2 is used. If a load 50 per cent of the normal is on for a given period of time, it will have the same heating effect a normal load will have for 25 per cent of the involved. As example, a load 50 per cent of the normal and for 10 seconds is converted to a normal load of 2½ seconds.

If a load is changing in magnitude, it is necessary to change it into an equivalent load of constant value. If the change is at a constant rate and starts or terminates at zero value, the equivalent constant load is $\frac{1}{3}\sqrt{3}$ of the peak or upper value. If the lower value of the changing load is other than zero, but if the change is at a constant rate, Figure 3 is used. The resultant equivalent constant load is then treated the same as any other constant load and is then converted into the equivalent time for a normal load.

After all loads have been converted into their equivalent time of normal load, the total time is added and, using the ratio of this time as compared to the time of the cycle, the rms value of the load is determined.

As an example, consider the load cycle as shown in Figure 4 and tabulated below.

Assume 10,000 hp as normal load.

Period number	Column A Hp	Column B Time—sec	Column C Per cent of normal load	Column D Equivalent time from Figure 2
1	9500	6.00	95.00	5.42
2	7200/4100	4.00	57.20	1.31
3	4100	2.00	41.00	0.34
4	0	3.00	0	0.00
5	0/8500	5.00	49.07	1.20
6	8500	5.00	85.00	3.61
		25.00		11.88

The ratio of 11.88 to 25 is 47.52 per cent. From Figure 1 the rms as compared to the normal load is 68.93 per cent, giving a result of 6,893 hp.

Column A tabulates the horsepower or whatever unit is used as an expression of load for the period of that time as shown in column B. Column C shows the load as a percentage of the assumed normal load. When the load in column A is constant this is simply the per cent ratio between the constant load and the normal load.

(*Please turn to page 98*)

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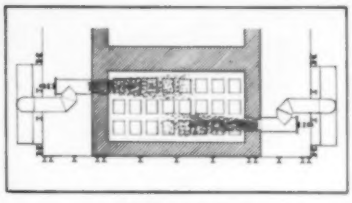
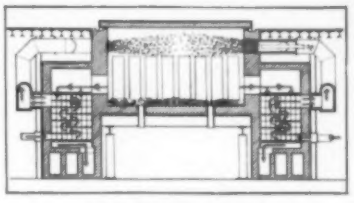


PLAN VIEW



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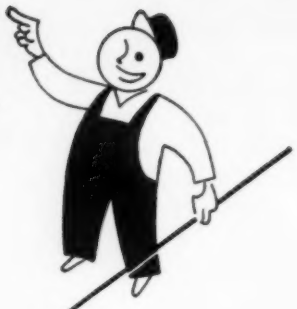

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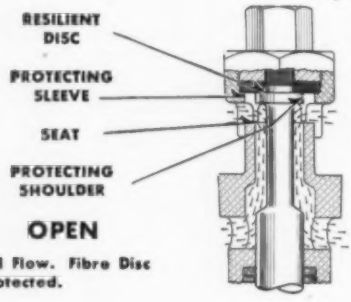

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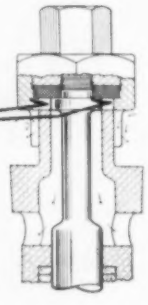

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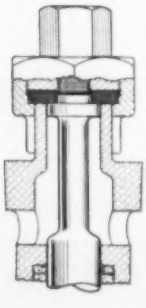

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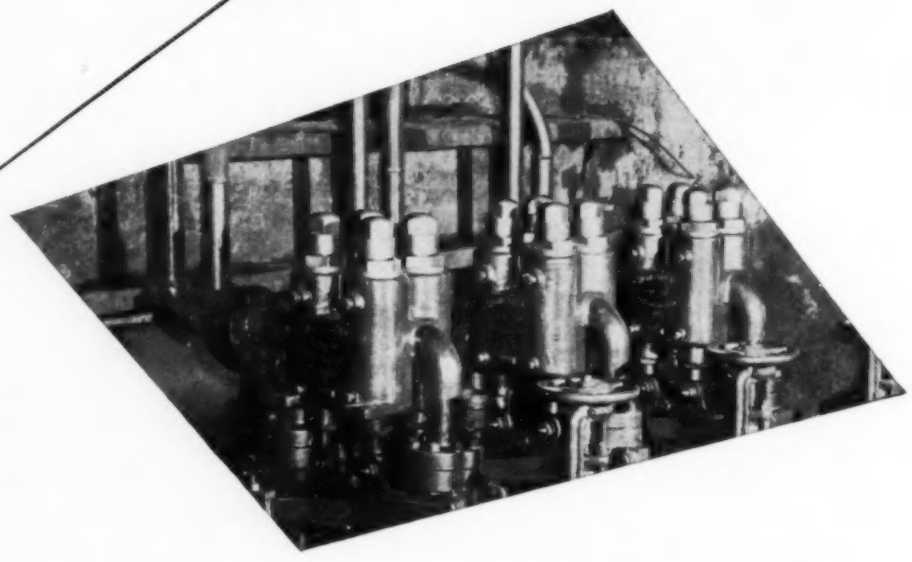

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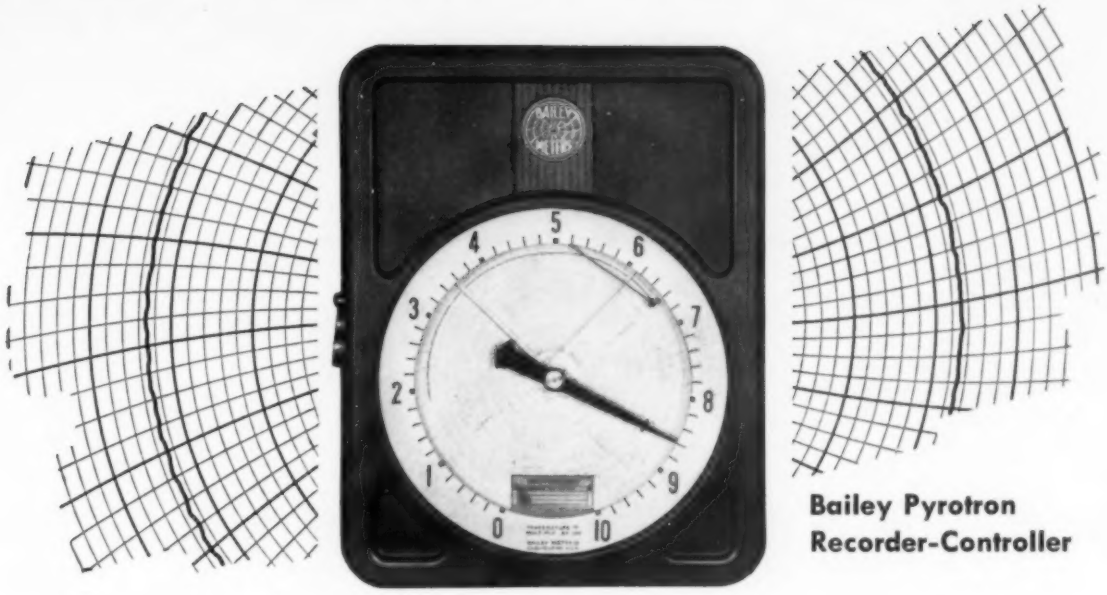

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Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

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The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

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DENSITY
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(*Continued from page 94*)

Where the load changed at a constant rate, Figure 3 is first used to obtain an equivalent constant load.

Column D is derived using the value shown in column C on Figure 2 and multiplying the result by the value of column B. The result shown in column D represents the equivalent time as based on full normal load. It is actually more accurate to derive D by multiplying column B by the square of column C than it is to use Figure 2.

The ratio of the total of column D to the total of column B represents the equivalent per cent of time that normal load is applied. Using Figure 1 and multiplying the result by normal load, the final answer, the rms value of load, is obtained. Instead of using Figure 1, the square root of the ratio of D to B multiplied by the normal load may be used.

Period No. 1 consisting of 9,500 hp on for 6 seconds as in Column A and B shows as 95 per cent of the normal load in column C. Curve No. 2 shows that when X = 95 per cent (column C), Y is equal to 90.25 per cent. Multiplying the 6 seconds by 90.25 per cent gives the equivalent time of 5.42 seconds (column D).

Period No. 2 consists of a tapering load from 7,200 hp to 4,100 hp in 4 seconds as shown in columns A and B. The ratio of the lower to the higher load, 4,100 to 7,200, is 56.94 per cent which is the X value of Figure 3. The Y value of this curve is 79.12 per cent, which multiplied by the highest value of this period of time (7200) gives an equivalent load of 5,720 hp which is 57.20 per cent of normal load as shown in column C. Figure 2 is then used to convert to the equivalent time for normal load; that is, the X value being 57.20 per cent, the Y value is 32.72 per cent which multiplied by 4 seconds gives an equivalent time of 1.31 seconds as shown in column D.

The addition of the equivalent time of 11.88 seconds for all six periods represents the heating effect that a load of 10,000 hp would give if operated on a 25-second cycle of time. The ratio of 11.88 to 25 or 47.52 per cent represents the X value of Figure 1 and the resulting Y value of 68.93 per cent times the normal 10,000 hp gives 6,893 hp which is the rms value.

The accuracy of this method will depend on the size of the curves that are used. As great a degree of accuracy as may be required is obtained by using the curves for reference only, and using the formulae shown on the curves for deriving the equivalent times. Two decimal points, as used above, is quite accurate as the correct answer is 6,892.54 hp.

In fact it is difficult to determine the rms when changing loads are used without the formula, or some derivation, as shown in Figure 3. Otherwise it is necessary to use a step by step method of one second intervals or less which gives a slightly inaccurate result.

This works out as follows:

Period	Load	Time	Load²	Load² Time
1	9500	6	90,250,000	541,500,000
2	6812.5	1	46,410,156	46,410,156
	6037.5	1	36,451,406	36,451,406
	5262.5	1	27,693,906	27,693,906
	4487.5	1	20,137,656	20,137,656
3	4100.0	2	16,810,000	33,620,000
4	0	3	000	000
5	850	1	722,500	722,500
	2550	1	6,502,500	6,502,500
	4250	1	18,062,500	18,062,500
	5950	1	35,402,500	35,402,500
	7650	1	58,522,500	58,522,500
6	8500	5	72,250,000	361,250,000
				1,186,275,624

Dividing this by the 25 seconds gives 47,451,025, the square root of which is 6,888 hp.

The mathematical equations of the curves are shown on the curves in terms of X and Y.

CURRENT AISE DISTRICT SECTION MEETINGS

CHICAGO SECTION

Tuesday, May 2, 1950 — Dinner 6:15 P.M.; Meeting: 7:45 P.M.

"Maintenance Symposium."

Phil Smidt's Restaurant, 1205 North Calumet Ave., Hammond, Ind.

Moderator: Frederic M. Darner, Chief Engineer
Manufacturing Division
Republic Steel Corp.
Cleveland, Ohio

Panel Members: C. A. Butler, Jr., Director of Engineering
Diamond Alkali Co.
Painesville, Ohio

R. W. Chaffee, Consulting Engineer
Cleveland, Ohio

Leonard Larson, Chief Engineer
Corrigan-McKinney Works
Republic Steel Corp.
Cleveland, Ohio
and
George S. Monks (Retired)

CLEVELAND SECTION

Monday, May 15, 1950 at Cleveland, Ohio — Dinner 6:30 P.M.; Meeting: 8:00 P.M.

Tuesday, May 16, 1950 at Youngstown, Ohio — Dinner 6:30 P.M.; Meeting: 8:00 P.M.

"The Organization of an Engineering Department."

Cleveland: Cleveland Engineering Society, 2136 East 19th St., Cleveland, Ohio.

Youngstown: El Rio Club, Youngstown-Warren Rd., Route 422, Youngstown, Ohio.

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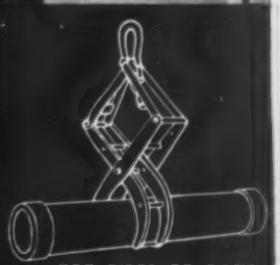

. . . FOR PIPES OR BARS

. . . PALLETS

. . . CYLINDERS

. . . BALES

. . . BARRELS

. . . SACKS

Pictorial

AISE SPRING CONFERENCE

▲ THE Annual Spring Conference of the Association of Iron and Steel Engineers, which was held in Birmingham, Ala., April 3 and 4, had a combined attendance of 650. Registration (1) and meetings were held in the Hotel Tutwiler. Simultaneous technical sessions were held on Monday, April 3. At the authors and chairmen breakfast were seen (2): J. W. Johnson, Tennessee Coal, Iron & Railroad Co.; D. W. Lloyd, Youngstown Sheet and Tube Co.; C. P. Hammond, Rotary Electric Steel Co.; J. H. Middleton, Republic Steel Corp.; and, R. W. Scholl, Connors Steel Co. Authors and chairmen for the other session were (3): J. R. Trimble, J. E. Hill, and E. A. Hawk, all of Tennessee Coal, Iron & Railroad Co.; C. G. Hogberg, U. S. Steel Corp.; and Walter Nielsen, Sloss-Sheffield Steel and Iron Co.

In the afternoon, the members and guests made an inspection trip through Connors Steel Co. in Birmingham.

Again Tuesday morning, April 4, simultaneous technical sessions were conducted. Seen at the authors and chairmen breakfast were (4): A. F. Eisel, United Engineering and Foundry Co.; Clark Lambert, Youngstown Sheet and Tube Co.; R. M. Lang, Atlantic Steel Co.; J. N. Imel, Jones & Laughlin Steel Corp.; and, William Herman, Keystone Steel & Wire Co. Participating in the other technical session were (5): Alex Henry, Tennessee Coal, Iron & Railroad Co.; E. L. Anderson, Bethlehem Steel Co.; R. H. Wright, Westinghouse Electric Corp.; B. H. Caldwell, Jr., General Electric Co.; and W. H. Stuck, Jones & Laughlin Steel Corp.

Among those attending the conference were (6): Arthur Scholl, Tennessee Coal, Iron & Railroad Co.;

Review

BIRMINGHAM, ALABAMA

Louis Moses, Bethlehem Steel Co.; R. H. Scholl, Pittsburgh Rolls Division, Blaw-Knox Co.; and C. E. Michaels, Tennessee Coal, Iron & Railroad Co. In a fellowship gathering are (7): G. T. Collatz, Cleveland Worm and Gear Co. and Farval Corp.; R. A. Kraus, Republic Steel Corp.; M. F. Harr, Bethlehem Steel Co.; M. G. Bowles, Bethlehem Steel Co.; E. C. Peterson, Birdsboro Steel Foundry and Machine Co.; and, W. M. Stillwell, Dingle-Clark Co.

A dinner was held Monday evening at the Tutwiler Hotel. Clayton Rand, syndicated columnist for several southern newspapers, gave a stirring political-humorous talk. At the speaker's reception, preceding the dinner, are seen (8) C. C. Wales, National Tube Co. with A. V. Wiebel, Tennessee Coal, Iron & Railroad Co. and C. H. Williams, Carnegie-Illinois Steel Corp. R. S. Lynch, Atlantic Steel Co. (9) greets H. P. Bigler, Connors Steel Co. and J. H. Black, Youngstown Sheet and Tube Co.

The climax of the activities at the Spring Conference was a tour (10) through the Fairfield tin mill at Tennessee Coal, Iron & Railroad Co., C. R. Bottenfield, general superintendent of the sheet and tin mills exchanges greetings (11) with A. S. Glossbrenner, president of the Association of Iron and Steel Engineers (and assistant vice president of operations, Youngstown Sheet and Tube Co). A group (12) watches coils of strip pass by cooling conveyor from 48 in. hot strip mill to the raw coil storage department. A. J. Fisher, Bethlehem Steel Co. and J. R. Green, Brown Instrument division, Minneapolis-Honeywell Regulator Co. watch (13) Margaret Whitburn as she examines finished tin plate for defects.

10

11

12

13

8

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A SERVICE ORGANIZATION

Date-line Diary...

March 1

▲ No. 2 blast furnace of Carnegie-Illinois Steel Corp., Edgar Thomson Works was blown out February 25 for reline.

▲ Department of Commerce announced manufacturers' sales in January were $17,600,000,000 or up $400,000,000 from December. Inventory values were $31,000,000,000 or practically no change from the previous month.

▲ The United States Steel Corp., Jones & Laughlin Steel Corp., and Sharon Steel Corp. signed contracts with the Blue Cross which will give hospitalization coverage to employees.

March 2

▲ The Westinghouse Electric Corp. is offering a new issue of 500,000 shares of common stock to be sold to employees at below market prices.

▲ Federal Judge Keech acquitted the United Mine Workers of contempt of court charges which had been based on the soft coal miners refusal to return to the pits.

March 3

▲ Price of No. 1 steel scrap dropped $1 to $31 a ton in the Pittsburgh district.

March 4

▲ Final figures for public construction in 1949 showed $4,100,000,000 of new work started or the most active year in history.

March 5

▲ The coal operators and John L. Lewis signed a new contract settling the coal strike. The agreement raises wages 70¢ a day to $14.75 and provides royalties for the welfare fund of 30¢ a ton, an increase of 10¢ a ton.

▲ New construction put in place in February totaled $1,400,000,000 or 21 per cent over February, 1949.

March 6

▲ Based on reports of companies having 93 per cent of the steel capacity of the industry, the operating rate of the steel industry is 73.5 per cent of capacity for the week beginning March 6th, 1950. This is equivalent to 1,401,100 tons compared with 1,404,900 tons one week ago.

▲ A new pension plan which provides increased benefits for the employees of the Weirton Steel Co. was announced today. The plan provides for an increase of 33⅓ per cent in retirement income benefits with no increase in the cost to the employees.

▲ Department of Commerce reported that personal income in January was at an annual rate of $212,900,000,000 or the highest level in twelve months.

March 7

▲ Department of Commerce reported that unemployment rose to 4,684,000 in February.

▲ Domestic freight car deliveries in February were 2,046 compared with 10,315 in February, 1949. The backlog of orders on March 1st totalled 26,055.

March 8

▲ U. S. exports in January dropped to $743,000,000, the lowest monthly figure since October 1946. Imports in January rose to $622,000,000.

▲ American Iron and Steel Institute reported that automotive manufacturers took a record 10,900,000 net tons of steel or 18.8 per cent of total shipments. This is a larger percentage than ever before.

▲ All coal production went back on a 5-day week as the hard coal workers settled with the operators.

March 9

▲ F. W. Dodge Corp. reported that contracts awarded for building and heavy construction in the 37 states east of the Rockies totalled $779,530,000 in February or 37 per cent over February 1949.

▲ The Jones and Laughlin Steel Corp. let their first contracts for the new open hearth plant on the South Side, Pittsburgh, Pa.

March 10

▲ The Aluminum Association reports that production of primary aluminum in January was 104,045,600 lb, up 25 per cent from December.

▲ General Electric Co. reported record profits for 1949 with a new high of $125,639,051 or $4.36 per share, even though sales were off 1.2 per cent from the previous year.

▲ Price of lead in New York was cut 1¢ to 11¢ a lb.

March 11

▲ The ICC authorized the Railway Express Agency to boost rates 10 per cent on first class less-than-carload shipments and second class articles.

March 12

▲ Crucible Steel Corp. reported net sales for 1949 were $99,393,000 compared with $130,799,000 in 1948. Net income after funded debt charges and income taxes was $1,352,000. Expenditures in 1949 for improvements was $7,259,000.

March 13

▲ Based on reports from companies having 93 per cent of the capacity of the steel industry, the operating rate of the industry is scheduled at 89.8 per cent of capacity for the week beginning March 13, 1950. This is equivalent to 1,711,800 tons of steel ingots and castings compared with 1,401,100 tons one week ago.

March 14

▲ The Jones & Laughlin Steel Corp. reported that sales in 1949 were $386,046,000 or 13 per cent less than 1948. Net income dropped to $20,961,000 ($7.50 per share) from $31,222,000 in 1948.

▲ Reconstruction Finance Corp. withdrew all fixed price quotations for the sale of its tin supplies, and from now on prices will be those prevailing in the open market.

▲ Soft coal operators in Pennsylvania raised prices 10 to 30¢ a ton for industrial purposes.

▲ General Motors reported sales in 1949 of $5,700,000,000, a new high or almost $1,000,000,000 higher than 1948. Profits set a new record and were equal to $14.64 a share.

▲ United Engineering and Foundry Co. reported net sales of $63,281,618, and net income of $5,654,080 in 1949.

March 15

▲ Granite City Steel Co. announced net income for 1949 at $2,958,000 or $7.44 a share.

▲ The U. S. Steel Corp. announced sales of $2,301,685,689 and a net income of $165,908,829 in 1949.

▲ Price of zinc rose ¼¢ to 10¢ a lb in East St. Louis. Tin rose ¾¢ to 75½¢ a lb in New York, and lead was cut ½¢ a lb to 10½¢ a lb in New York.

▲ The House approved another version of the basing point bill which now goes to the Senate.

▲ The hard coal producers increased prices from 10¢ to 75¢ a ton.

▲ The Texas Eastern Transmission Corp. concluded a contract with Algonquin Gas Transmission Co. for delivery of up to 250,000,000 cu ft of natural gas a day for resale to utilities in the New England area. New facilities required will cost about $60,000,000.

March 16

▲ Trade Minister Howe announced that Federal steel control in Canada would end on March 31st. Termination results from an estimate that the world shortage of steel is now at an end.

▲ United States Steel Corp. is putting back into production 1400 beehive ovens in Western Pennsylvania, which have been out of operation since the miners union started the three day week in July 1949.

▲ The Allis Chalmers Manufacturing Co. reported a profit of $18,755,461 ($6.99 a share) compared with $15,441,523 in 1948. Total sales were $351,097,878.

▲ Tin advanced 1¢ to a price of 76½¢ a lb in New York.

▲ Proposed government purchase lists will be made available to business firms at 149 field offices in the United States. Information will be given out by the General Services Administration and the Defense Department.

▲ Senator Taft in a minority comment on the report of the House Senate Economic Committee concluded that competition in the steel companies was reasonably active. He also reported "I do think there is a doubtful question, namely whether the position of U. S. Steel Corp. is so predominant that it has power to fix prices and at least modify the usual effect of competition."

March 17

▲ The Joy Manufacturing Co. reported that they had received an order for over $1,000,000 of equipment for mechanization of iron ore mines in France.

March 18

▲ Bureau of Labor Statistics reported that home building started a record 1,025,800 dwelling units in 1949.

March 19

▲ Youngstown Sheet and Tube Co. has scheduled expenditures of $25,000,000 for improvements in plant expansions in 1950.

March 20

▲ The Sloss-Sheffield Steel & Iron Co. of Birmingham expect to spend several million dollars on modernization in the next few years. Included is a project to install two modern steam generators at blast furnaces No. 3 and 4.

▲ Based on reports of companies having 93 per cent of the capacity of the steel industry, the operating rate of the industry is scheduled at 95.5 per cent of capacity for the week beginning March 20, 1950. This is equivalent to 1,820,500 tons of steel ingots and castings compared with 1,711,800 tons one week ago.

▲ A new electrolytic tinning line is to be installed at Yorkville Ohio by the Wheeling Steel Corp. at an estimated cost between $3,000,000 and $4,000,000.

▲ No. 1 heavy melting scrap sold for $32 a ton in the Pittsburgh area.

March 21

▲ The Timken Roller Bearing Co. announced that they plan to build two new roller bearing manufacturing plants at Bucyrus, Ohio at a cost of about $4,250,000.

▲ The A. O. Smith Corp. of Texas expects to put into production their $5,000,000 welded steel pipe mill about August 1.

March 22

▲ The House Appropriations Committee reported out a bill which will cut $1,385,000,000 from President Truman's budget.

▲ As a result of a rise, coke prices at Connellsville now range from $14 to $14.50 on furnace coke and $16 to $16.50 on foundry grade coke.

▲ About 5,329,000 tons of iron ore were used in blast furnaces in February which is an appreciable reduction from January. Reduction was caused by coal shortages.

March 23

▲ The Lukens Steel Co. as a result of steel demand placed its ninth open hearth in operation today.

▲ American Iron and Steel Institute reported that the payroll for the iron and steel industry in January was $189,346,000, the highest since April 1949. Average hourly payments were $1.72 an hour with total employment at 609,400. Workers averaged 38.5 hours per week.

March 24

▲ Chrysler Corp. offered to set up a $30,000,000 fund to pay $100 monthly pensions to retired employees. Pensions would be entirely financed by the company.

March 25

▲ The AISC reported total bookings of fabricated structural steel in February were 110,528 tons compared with 108,764 tons in February 1949. The backlog for the next four months stands at 565,428 tons. Shipments in February were 122,614 tons.

March 26

▲ The stockholders of the National Steel Corp. voted today to split the stock on a three-for-one basis.

▲ The majority report of the joint committee on the Economic Report recommended systematic studies by FTC of price costs and profits of the major steel producers, that this information be kept on record, notification to FTC thirty days in advance of proposed price increases, further study on means to engender more competition, and finally a study to determine whether the steel industry should be treated as a public utility.

March 27

▲ Shipments have started at the new steel plant in Chile, and completion of this plant will take place in the near future.

▲ The Kaiser Steel Co. has under construction two new soaking pits at Fontana, which when completed will have a total of 16 pits. This work completes the $35,000,000 expansion program now under way.

▲ Based on reports of companies having 93 per cent the capacity of the steel industry, the operating rate of the industry is scheduled at 96.7 per cent for the week beginning March 27, 1950. This is equivalent to 1,843,400 tons of steel ingots and castings compared with 1,820,500 tons one week ago.

March 28

▲ An International Tin Studies Group is now meeting to determine whether tin dealings can be placed under United Nations supervision.

▲ The Department of Commerce reported that total sales in February were $17,700,000,000 or up $100,000,000 from January. Since new orders in February totalled $18,200,000,000 manufacturers backlogs were thus increased.

March 29

▲ Great Britain ordered cuts in purchases from the United States and the volume for the year beginning July 1 will be $1,180,000,000 or 26 per cent below 1949.

▲ Ernest T. Weir stated that steel production in the United States is definitely in excess of the requirements of this country.

March 30

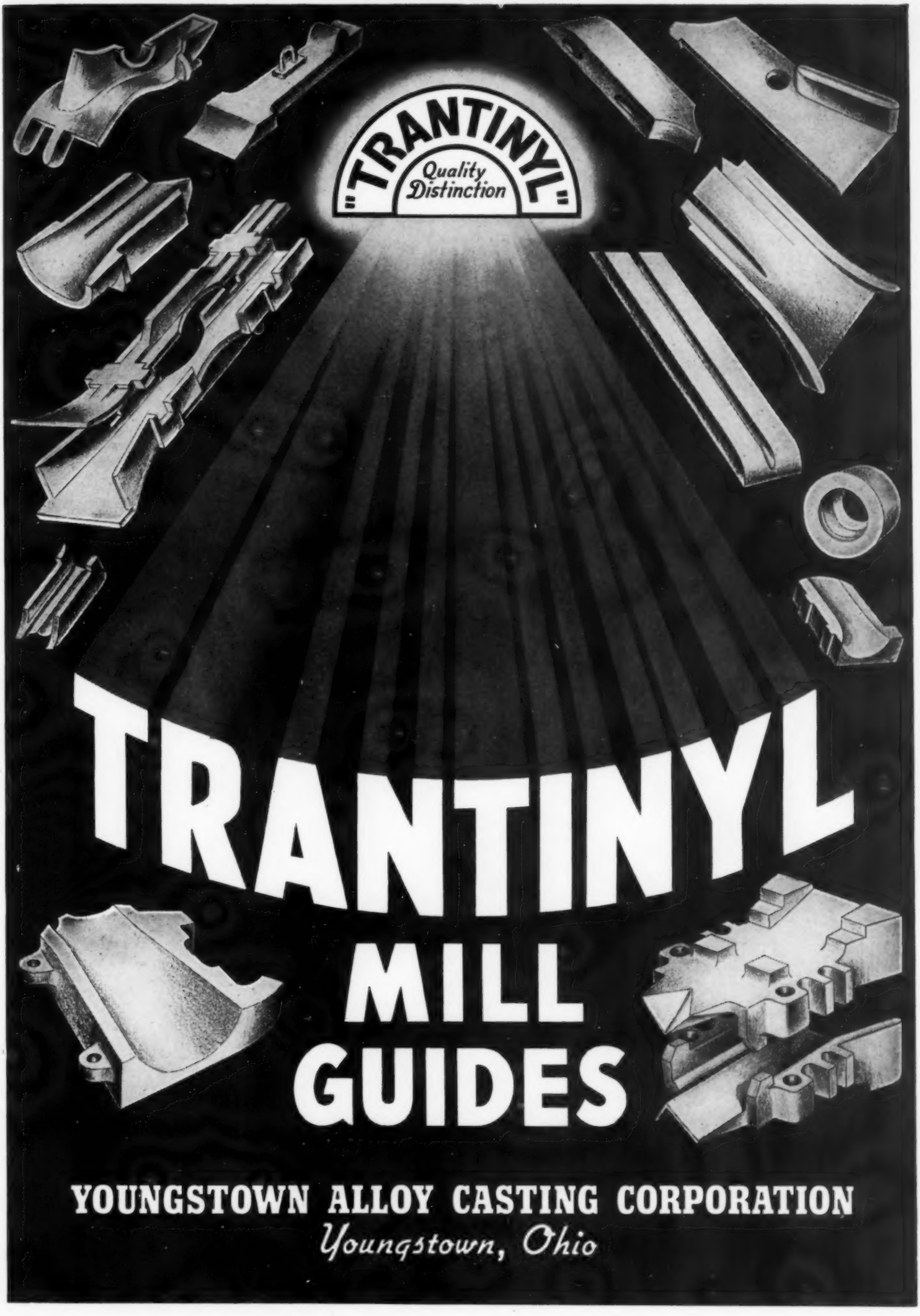
▲ The Carnegie-Illinois Steel Corp. has put back into production No. 4 furnace at Edgar Thomson Works, and Ohio Works No. 5.

▲ The National Steel Corp. reported net earnings for 1949 of $39,311,269 or $16.02 a share. Total sales were $424,892,845. Both earnings and sales were slightly under 1948.

March 31

▲ The Republic Steel Corp. reported total sales in 1949 of $656,898,258 and earnings of $46,142,323. Both figures were slightly under 1948.

▲ The SEC and Commerce Department estimated that American business will spend $16,100,000,000 in 1950 for plant and equipment.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OHIO PROTECTO-WELD MAGNET is welded *on top*, where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

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Industry News...

U. S. STEEL REPORTS EXPENDITURES OF $875,100,000 IN POST WAR PROGRAM

▲ U. S. Steel's management has confidence in the future of this nation, as is evidenced by its costly facilities program over recent years, Irving S. Olds, chairman of the board of directors, declared in the annual report of the corporation for 1949, made public recently.

During the year 1949, U. S. Steel expended $179.1 million for additions to and replacements of its facilities, or $59.4 million more than its total wear and exhaustion for the year, Mr. Olds said, adding that "in the postwar period, U. S. Steel has expended $875.1 million for facilities. At December 31, 1949, $167.6 million was the estimated amount required to complete all authorized replacements and additions.

"U. S. Steel's rated annual capacity at January 1, 1950, for the production of steel ingots and castings was 32.0 million tons. U. S. Steel's capacity is 32.2 per cent, or less than one-third, of the total ingot capacity of the nation, its competitors having slightly more than two-thirds of such total. The percentage of capacity owned by U. S. Steel in relation to the total capacity of the nation has shown a downward trend since the earliest years of the Corporation's existence. In 1902, U. S. Steel possessed 44.2 per cent of the country's steel capacity and produced 65.2 per cent of all the steel made that year in the United States.

"Although its relative size in the steel industry has grown smaller with the passage of time, U. S. Steel has expanded its ingot capacity threefold since its first year of operation—from about 11 million to 32 million tons. During 1949 more than 700,000 tons of additional ingot capacity became available through the completion of new and improved steel making facilities."

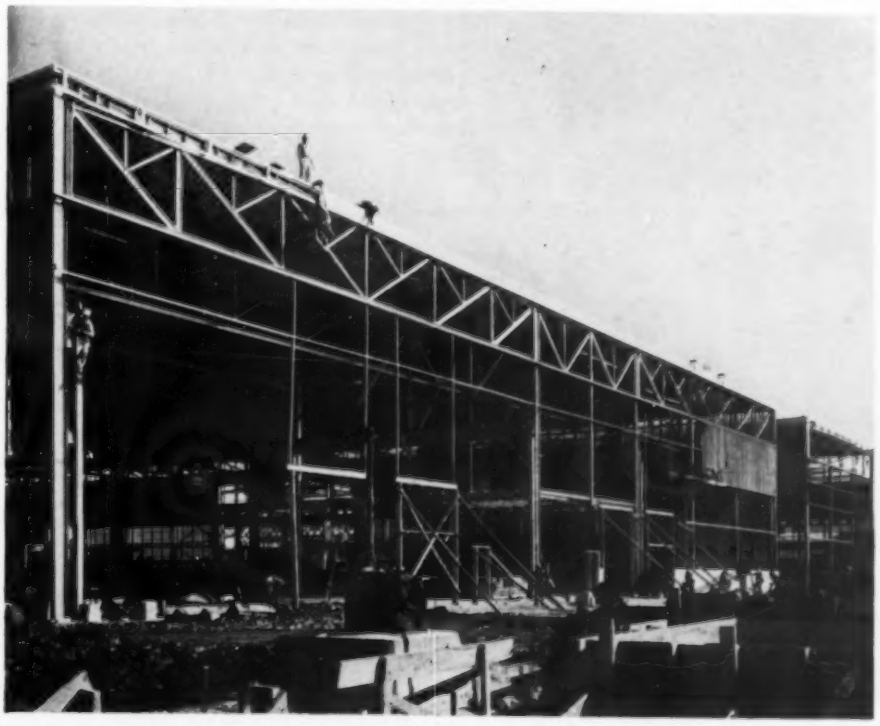
Discussing the corporation's raw material problems, Mr. Olds says: "For nearly half a century, despite two major wars and increasing peacetime steel consumption, U. S. Steel has been able to provide an adequate supply of iron ore essential to its steel making operations. In addition, U. S. Steel has sold substantial quantities of iron ore in the open market.

"The problem of an adequate supply of iron ore for the future is being approached by U. S. Steel on two fronts—the refining of ores of lower grade from the Lake Superior district and the development of extensive, newly discovered iron ore deposits in Venezuela. It is obviously not prudent or in the national interest to exhaust unduly the remaining iron ore reserves of higher grade in the Lake Superior district.

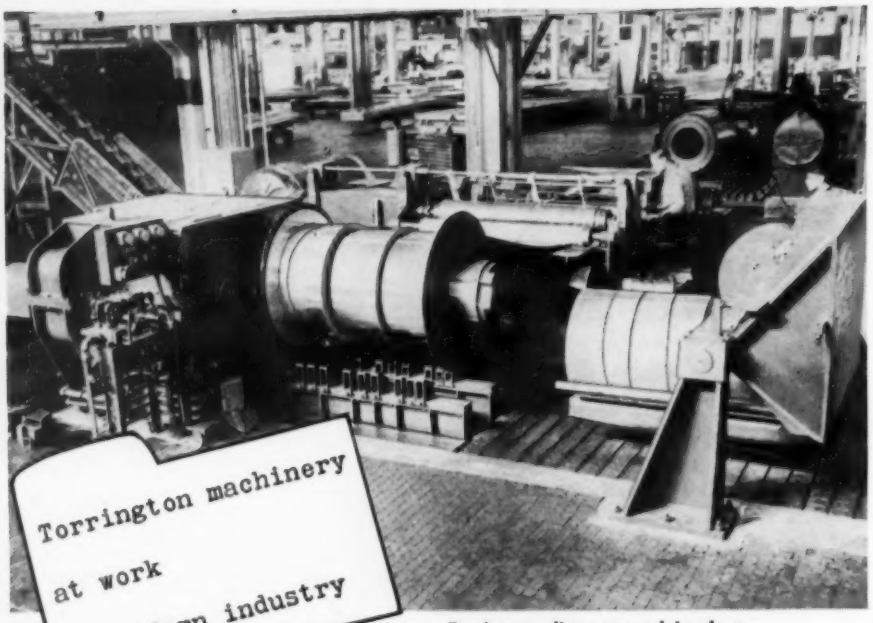
"Within the borders of the United States there are abundant supplies of taconite, a hard iron-bearing rock containing about one-third iron. Beneficiation of taconite into lumps or pellets containing sufficient iron for use in blast furnaces requires a series of refining steps now under thorough investigation, involving heavy capital expenditures.

"During 1949 a basic new source of high-grade foreign iron ore came nearer to possible future utilization in this country. After several years of extensive exploratory work in many regions of the world, substantial new deposits of high quality iron ore were discovered by U. S. Steel in Venezuela. Rights to mine these deposits have been obtained from the Venezuelan government. A new subsidiary of United States Steel Corp.—Orinoco Mining Co.—has been organized to undertake the development of this property, which on the results of the drillings so far made seems to com-

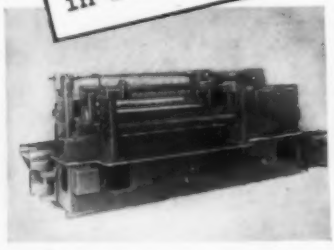
A. O. SMITH BUILDS NEW PIPE MILL



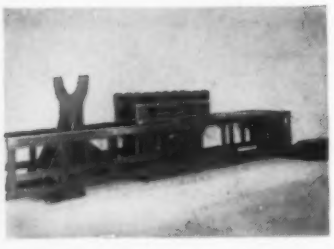
Workmen are rushing to completion the pipe mill of the A. O. Smith Corp. of Texas, which will be one of the world's largest producers of large diameter welded steel line pipe and casing for the oil and gas industries. This view shows installation of corrugated asbestos siding and steel sash along the front of the main plant building. The plant was designed by Austin Co. which is also handling installation of machinery. It is located near the Houston ship channel, adjoining the Houston mill of Sheffield Steel Corp., which will furnish a major portion of the steel plate for the pipe making operations. It will go into production about August 1.



Torrington slitter at work in plant.



Torrington's Latest Slitting Equipment in Newest Plant of ALUMINUM COMPANY OF AMERICA



The newly constructed plant of Aluminum Company of America, Davenport, Iowa, houses the last word in slitting equipment by Torrington. This heavy duty machinery combines famous Torrington standards—advanced design—dependable accuracy plus ability to withstand abuse under exacting heavy service. This unit contains feed rolls, slitter, scrap chopper, winder, collapsible block, stripper, elevator carriage upender and scrap conveyor. Outstanding features are:

Top: Slitter part with feed rolls. Next: Stripper and elevator carriage. Last: Winder.

- Speed as high as 1200 feet per minute
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- Scrap chopper driver from independent motor
- Power expansion of collapsible block
- Stripping and upending by power

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pare in importance with the famous Hull-Rust-Mahoning Mine in Minnesota."

FARREL-BIRMINGHAM CENTRALIZES GEAR SALES

▲ Farrel-Birmingham Co., Inc., will move to its main offices at Ansonia, Conn., the gear sales division which has been located at the company's plant in Buffalo, N. Y., and the marine sales division presently connected with the New York office. Carl Hitchcock, vice president in charge of sales, stated that these moves are in line with the company's policy to coordinate and centralize, as much as possible, various departmental functions.

R. C. Wilson, manager of Buffalo sales for several years past, will continue in that capacity, with headquarters at Ansonia after April 1st. In addition to Mr. Wilson, Pierce Birkoff and J. H. Allen of the Buffalo sales staff will also transfer to Ansonia, where they will continue to handle the sale of gears, speed reducing and speed increasing units, and flexible couplings. The sale of gear generating machines and gear cutting tools will continue at Buffalo under William C. Oberem. John Brandt will remain in the Buffalo territory as sales representative for all Farrel-Birmingham products.

The engineering and manufacturing departments will continue at the Buffalo plant as at present.

INSULATION FACTORS IMPROVE WITH TIME

▲ Calling attention to a recent test by the National Bureau of Standards, Marshall F. Allen, manager of Magnesia Insulation Manufacturers Association, points out that figures heretofore in common use for the "k" factor and density of 85 per cent magnesia insulation are based on tests conducted by the Bureau in 1919.

The recent test made on 85 per cent magnesia block of current manufacture, weighing 13.2 lb per cu ft, indicated a k-factor, or thermal conductivity value, of 0.39 at 130 F mean temperature. According to Mr. Allen, these values are in close agreement with averages of the results obtained in numerous conductivity tests by the manufacturers on the current prod-

uct. These averages were given as follows:

Mean Temp F	k
100	0.39
300	0.45
500	0.51

The k-values cited are expressed in units of Btu per hr per sq ft for a temperature gradient of one deg F per in. of thickness.

"These values represent no sudden change, of course," Mr. Allen stated. "They are simply up-to-date figures, representing steady improvement since the last Bureau of Standards tests were made some thirty years ago."

SESA TO HOLD CLEVELAND MEETING

▲ The Spring Meeting of the Society for Experimental Stress Analysis will be held at Hotel Statler, Cleveland, Ohio on May 25, 26, and 27, 1950. Inquiries should be addressed to the Society for Experimental Stress Analysis, P. O. Box 168, Cambridge 39, Mass.

STEAM-HEATED HOPPER GIVES STEADY COAL FLOW

▲ By steam-heating and insulating only the outlet tip of a 120-ton rooftop hopper, the Stauffer Chemical Co., Niagara Falls, N. Y., keeps coal flowing, without interruption, to boiler furnaces in below-zero winter weather. Copper tubing is helically wound around the outside of the hopper tip to carry steam at 340 F. Maximum heating value is obtained from the steam, and waste heat to the atmosphere is eliminated, by encasing the tube-bank in a mineral wool blanket covering. Coal has no chance to freeze at the hopper outlet and continuously feeds, by gravity, to the boiler furnaces below. Coal above the insulated tip keeps pressing downward into the tip as it empties.

Insulation is applied to the conical tip as follows: (1) Two-inch thick mineral wool blankets are cut and shaped to fit the surface of the tip of the cone. Blankets are supplied with wire mesh netting attached on one face and expanded metal lath on the other. The wire mesh netting is installed next to the copper tubing. Adjacent blanket sections are laced tightly together by galvanized wire woven through the abutting expanded lath coverings. (2) A half-inch layer of mineral wool insulating cement is trowelled onto the metal lath. (3) A one-quarter-inch coat of fib-

The main section of the hopper itself is cylindrical, only the lower section being conical.

SAVE TIME

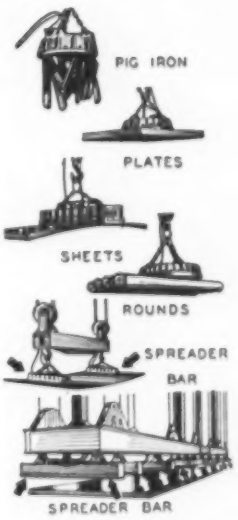
You can cut down the time for loading, unloading and moving hard to handle materials . . . and make a direct saving of hand labor. Whatever your job, STEARNS Lifting Magnets will help you save time and money.

Stearns LIFTING MAGNETS

STEARNS Lifting Magnets are being successfully and profitably used in handling scrap iron, steel plates, coils, bundles, strip steel, rails, slabs, billets, pig iron, castings, borings, turnings as well as finished products. The problem of loading or unloading . . . or moving large quantities of material quickly at a low cost — easily solved with STEARNS Lifting Magnets.

For the efficient handling of flat steel sheets, plates and regularly shaped steel bars and structural steel sections, be sure to investigate STEARNS Rectangular Lifting Magnets.

STEARNS Lifting Magnets pay for themselves in a short time, require surprisingly little attention, and are your best bet for economical, fast and safe moving of material.



Standard sizes available in both bolted and all welded constructions. Special sizes and shapes made to your requirements.

Stearns MAGNETIC MANUFACTURING CO.

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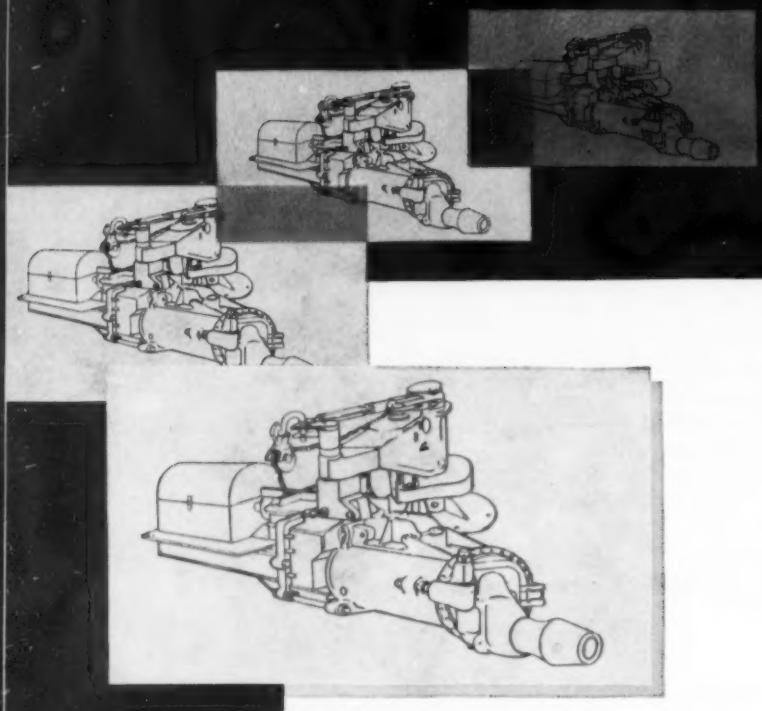
Remember to specify

BROSIUS

for ruggedly built
more efficient Clay Guns



Here are two very good reasons why Brosius Clay Guns are so highly practical to operate and maintain. First, they are backed by many years of specific blast furnace engineering skill and experience; and second, each gun is individually designed, machined, assembled, inspected, and tested at the Brosius factory. For more information and literature on sturdy low-cost electric-mechanical, electric-hydraulic or steam guns, simply write to us.

Edgar E.
BROSIUS
Company Inc.
SHARPSBURG • PITTSBURGH 15, PA.

rated asphaltic emulsion is applied over the cement. (4) After drying, the asphaltic emulsion is then painted with a prime coat of aluminum paint and the completed installation painted the same color as the hopper.

The main section of the hopper itself is cylindrical in shape, only the lower section being conical. About 50 tons of coal per day are used by the plant and this tonnage is daily brought into the hopper by a bucket-type conveyor-elevator. The hopper holds enough coal for several days. Thus, mechanical failure of the elevating system would not result in down-time.

Similar insulated applications of heat will prevent freezing up of outdoor hoppers having other purposes —for example, handling ores, granulated chemicals, and building products.

L. J. WING MFG. CO. CONSOLIDATES PLANTS

▲ L. J. Wing Mfg. Co., manufacturers of heating, ventilating and combustion equipment and steam turbines, with three separate factories in Newark, N. J., and with general offices in New York City, consolidated all of these in a single modern factory building at Linden, N. J.

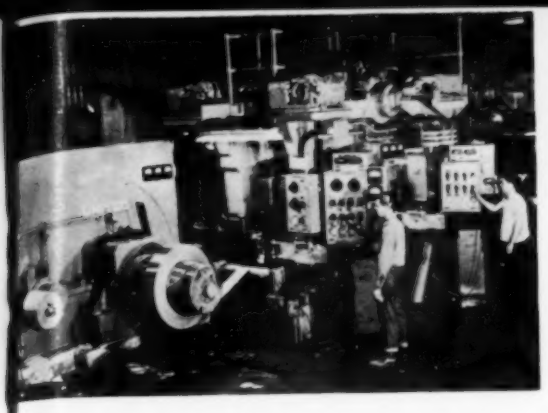
While much needed additional facilities will be provided, including extra land for future growth, the consolidation's principal purpose is to effect closer and more efficient interdepartmental cooperation.

BARIUM STEEL & FORGE ANNOUNCES NAME CHANGE

▲ Industrial Forge & Steel, Inc., is the new name of Barium Steel & Forge, Inc., a subsidiary of Barium Steel Corp. at Canton, Ohio.

WALLINGFORD STEEL INSTALLS NEW STRIP MILL

▲ Wallingford Steel Co., Wallingford, Conn., announces addition of a new two-stand, four-high tandem mill manufactured by United Engineering & Foundry Co., Pittsburgh, Pa. Used in the breakdown of stainless and carbon steel, it is said to reduce strip gage by as much as 40 per cent in a single pass.



The new two-stand, four-high mill will be used to process carbon and stainless steels at speeds up to 800 fpm.

The new mill is, in effect, two mills, combined in tandem and operating on strip from the same payoff. Each unit has two backing-up rolls and two work or polish rolls. Electro limit gages for checking tolerances are standard components. The mill is reported to be capable of cold-reducing 18-in. stainless and 22-in. carbon strip from 0.160 to 0.010-in. at speeds up to 800 fpm.

The addition of this new equipment is said to enable Wallingford to supply various types of steel more quickly than heretofore. It is part of the present $1,500,000 expansion program of the corporation.

J&L LETS CONTRACT ON OPEN HEARTH PLANT

▲ Jones & Laughlin Steel Corp. will start construction work this summer on the planned new open hearth plant at its Pittsburgh, Pa., works.

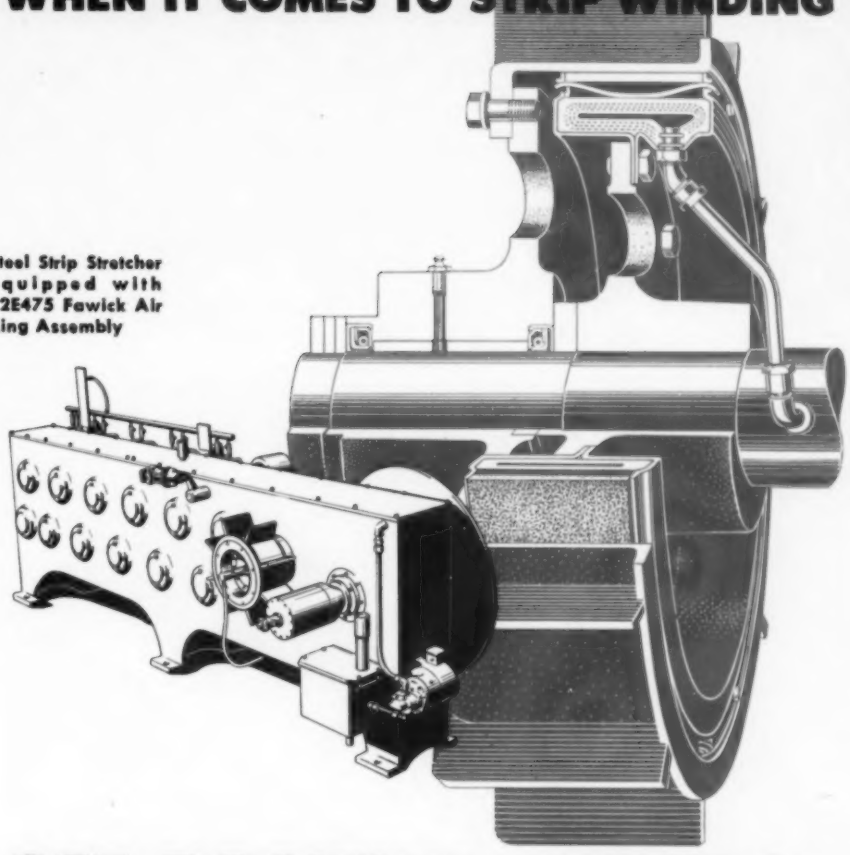
Contracts have been let for 15,000 tons of structural steel for the project, which will include six new 250-ton open hearth furnaces and a railroad viaduct leading into the plant.

The new steelmaking open hearths with auxiliary facilities will have a total capacity of about 800,000 tons or more a year. J & L plans to dismantle some of its present marginal open hearth facilities at the Pittsburgh works so that the company's net gain in ingot capacity from the new furnaces will be about 400,000 tons of steel ingots a year.

Finishing operations at the Pittsburgh works will be stepped up to handle the increased output from the new furnaces which are expected to be finished late next year.

The planned new open hearth furnaces are part of a $70 million expansion improvement program at J & L's Pittsburgh and Aliquippa, Pa. plants.

WHEN IT COMES TO STRIP WINDING



Steel Strip Stretcher equipped with 12E475 Fawick Air Ring Assembly

GET POSITIVE CONTROL WITH FAWICK

Fawick "E" clutches provide strip winding machines with much more than complete tension control.

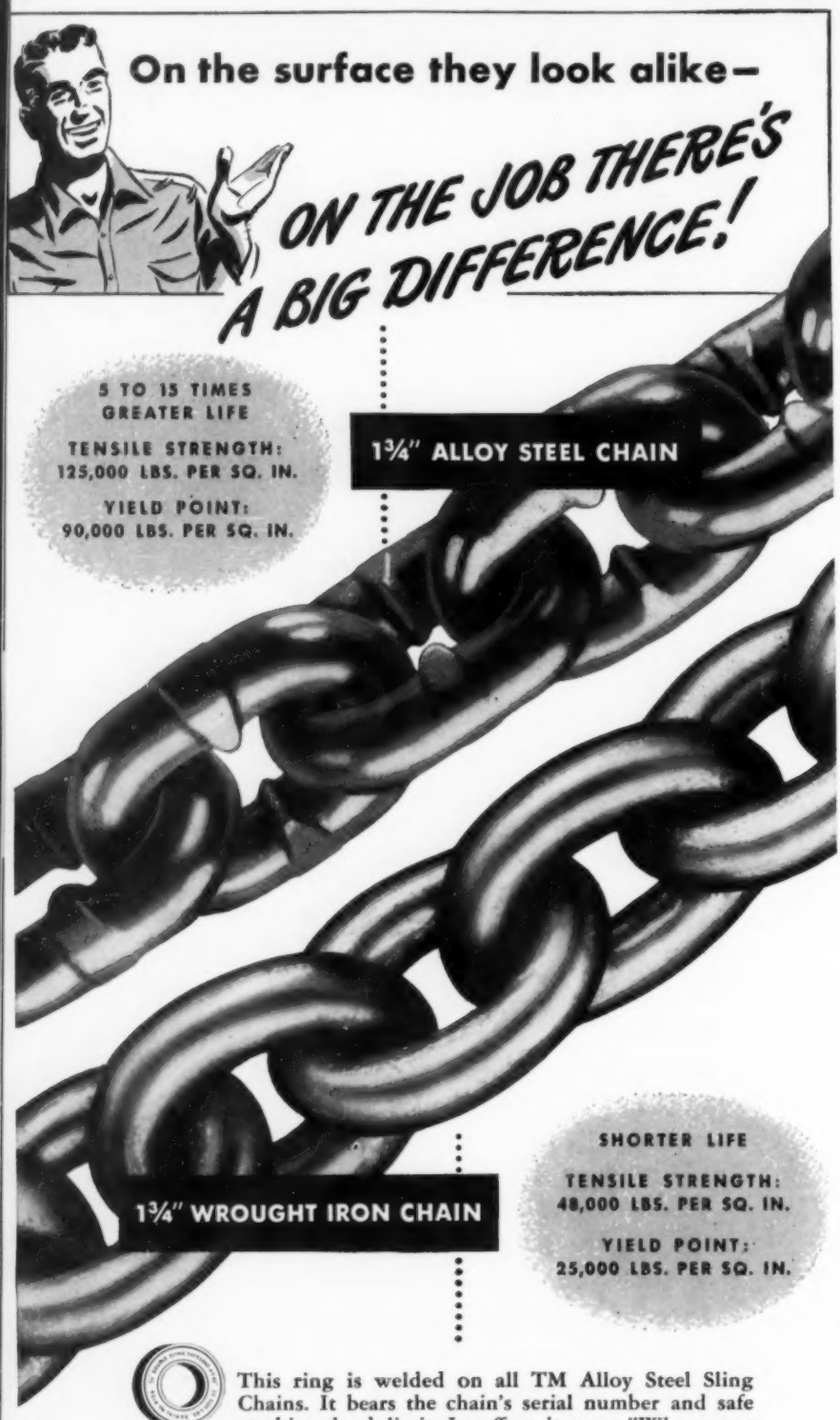
Fawick design and operating features provide: (1) 360° constant-velocity contact with the friction surface; (2) rugged construction for heavy-duty applications; (3) sensitively controlled torque through variation of applied air pressure; (4) full operating control at all speeds; (5) practical remote control; (6) automatic self-adjustment to compensate for wear.

For specific information on all advantages of Fawick Clutch and Brake units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

All desirable clutch characteristics are built into Fawick Airflex units

FAWICK Airflex CO., INC.
9919 CLINTON ROAD CLEVELAND 11, OHIO

FAWICK CLUTCHES = = PEAK EFFICIENCY


On the surface they look alike—
ON THE JOB THERE'S A BIG DIFFERENCE!
5 TO 15 TIMES GREATER LIFE
TENSILE STRENGTH: 125,000 LBS. PER SQ. IN.
YIELD POINT: 90,000 LBS. PER SQ. IN.
1¾" ALLOY STEEL CHAIN
1¾" WROUGHT IRON CHAIN
SHORTER LIFE
TENSILE STRENGTH: 48,000 LBS. PER SQ. IN.
YIELD POINT: 25,000 LBS. PER SQ. IN.

This ring is welded on all TM Alloy Steel Sling Chains. It bears the chain's serial number and safe working load limit. In effect it says: "When your lifting requirements are big and your present chain performance leaves something to be desired—it's time to switch to TM Alloy Steel Chain." It's tougher... safer and far more economical than ordinary wrought iron chain. Used by steel, automotive, petroleum, marine and manufacturing industries generally, because *comparison, experience and costs proved its superiority.* For all the facts, write today for free copy of new booklet; "TM Alloy Steel Chain". The S. G. Taylor Chain Company, 65-141st St., Hammond, Indiana.

See your Mill Supply Distributor or send today for free copy of new TM Alloy Steel Chain Booklet!

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OLIVER STARTS WORK ON TACONITE PLANT

▲ The taconite program on the Mesabi is beginning to bud. Oliver Iron Mining Co. started construction on April 1 of a new type agglomeration plant at Virginia for processing Minnesota taconites and fine ores. It will be a new industry for the iron range with a payroll of over a quarter million dollars per year.

Reference to the new project was made by R. T. Elstad, president of U. S. Steel's mining subsidiary, in an address before the recent annual meeting of the Virginia Chamber of Commerce.

"This major experiment," Mr. Elstad states, "is one of the bold and costly steps in a 17 to 20 milion dollar program to secure basic information before building permanent commercial taconite plants." The program includes five major stages: Exploration, research, mining, separation and cementing together, or agglomeration, of the powder-fine iron mineral.

Agglomeration, according to Mr. Elstad, is one of the most difficult steps because the product must retain its properties under all kinds of weather conditions, including rain, freezing and thawing in the year-round operation of taconite plants. It must be strong to withstand the severe handling on its way to the furnaces; it must also have desirable physical properties in order to make furnace operation economical.

The new plant will be the first combination sintering and nodulizing pilot plant on the Mesabi Range, and will have the capacity to produce approximately 1,000,000 tons per year. Site chosen for the unit is adjacent to the present Rouchleau crushing and screening plant because of established unloading and working facilities, and will cover about 3 acres. It is expected to be completed by the end of this year and will be constructed for the Oliver Co. by the Arthur G. McKee Co., Cleveland, Ohio.

Of the three main buildings the largest, which will house the sintering machine and the raw material section, will be five stories high, 400 ft long and 60 ft wide. Approximately 3,200 tons of steel will be required and will be furnished by the American Bridge Co., which will also have charge of steel erection.

During the breaking-in period, and

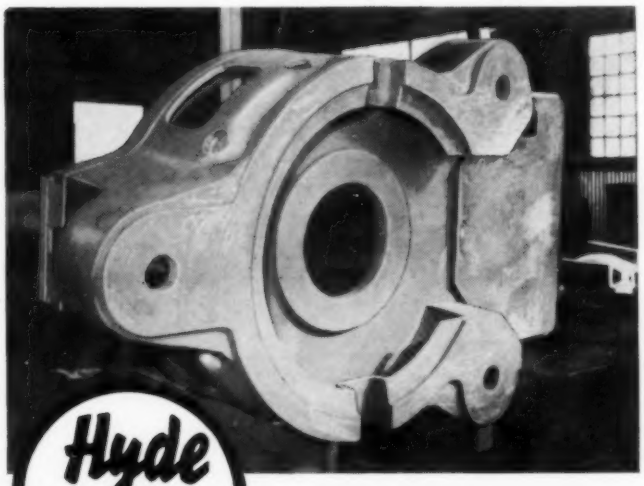
until taconites are available from the first pilot plant, fine ores and concentrates from many of Oliver's washing plants and open pit mines will be brought to the Virginia plant by rail. Agglomeration of fine particles, which are too small to be worked properly in the furnace, will be done here instead of at the Lower Lake furnaces.

Various methods of agglomerating have been tried by the industry, such as pelletizing, briquetting and sintering, Mr. Elstad explained, but it is not yet known which one will be the most economical and make the best product for the furnaces. This plant will experiment with only two of the methods, nodulizing and sintering, in an effort to select a method for agglomerating taconite to become a part of the permanent commercial taconite plant wherever it is built.

In the operation of the pilot plant, fines will be separated from the coarser material by a vibrating screen and then will be carried by conveyor belt to ten 750-ton capacity storage bins at the nodulizing and sintering plant. The coarse product from the screens will be loaded into cars for shipment as at present. Taconite and

AIR HEATERS CUT COSTS IN FOUNDRY PLANT

For nearly half a century, the Pittsburgh, Pa. plant of Rosedale Foundry & Machine Co. had been heated by hand-fired coke-burning salamanders. Company officials figured the building, with its uninsulated metal walls and 48½-ft high roof, could not be heated economically by any other method. Then they carefully analyzed costs. They found that by installing modern, gas-fired heaters there would be an immediate net savings of $402 a year in fuel and labor costs. In four years, after the new equipment is amortized, the annual savings will amount to $4372. With four new Dravo "Counterflo" heaters to replace 39 salamanders in the shop, which has more than 27,000 sq ft of floor space, uniformly comfortable temperatures for employees have been provided.



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Up to 80,000 Pounds

for Steel Mills and Heavy Machine Tools

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ROLLING MILL MACHINERY

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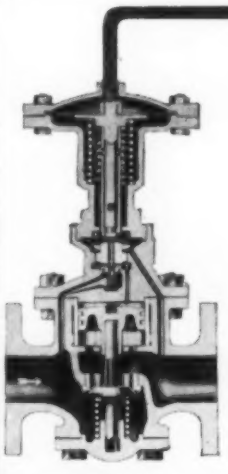
HYDE PARK FOUNDRY & MACHINE CO.

HYDE PARK, PA. (PITTSBURGH DISTRICT)



CLASS LT-3
REDUCING VALVE

TRADE LESLIE MARK

CLASS LT-3
REMOTELY ADJUSTED
REDUCING VALVE
with
AIR LOADING PANEL

An ideal combination for Steam Heating Systems where valves are inaccessible for re-adjustments. Avoids wasteful overheating. Saves time and eliminates safety hazards.

Write for Bulletin 461

TYPE ARP
Air Loading Panel

LESLIE CO.

247 Grant Avenue • Lyndhurst, N. J.

ESTABLISHED 1900 LESLIE CO.

PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS
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SELF CLEANING STRAINERS • LESLIE-TYFON WHISTLES

MEDART MULTICYCLE

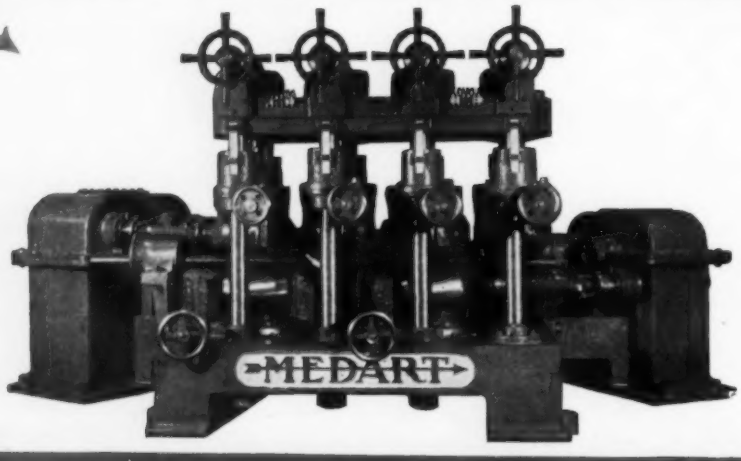
PIPE AND TUBE STRAIGHTENING MACHINE

"6 in 1"

SIX POINTS OF SUPERIORITY IN ONE

1. MULTICYCLE STRAIGHTENING—Two bending rolls impose duplex straightening cycles on workpiece insuring end to end straightness.
2. POSITIVE AND SYNCHRONIZED FEED—All four feed rolls are driven insuring positive synchronized feed and torque balanced around neutral axis of workpiece.
3. THE WORKPIECE LEVEL—Maintains one feeding level for all sizes of pipes or tubes—eliminates need of adjustable entry and delivery tables.
4. NO GUIDES—Horizontal position of the six rolls with balanced torque eliminates requirement for guides.
5. SINGLE MOTOR—All four driven rolls powered from a single motor, for synchronization and economy.
6. NO BEVEL GEARS—All gears enclosed in cases and running in oil, for sure trouble free operation.

"Patents make Jobs"



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY • 3600 DE KALB ST. ST. LOUIS, MO.

fine concentrates from concentration plants will be handled through the same bins.

Taken from the storage bins to either the sintering machine or nodulizing kiln by conveyor belt, the fines, through treatment in either process, will be agglomerated into larger sized material for blast furnace use.

The sintering machine will be 6 ft wide and 96 ft long. The fines will be mixed with coke in pug mills and the material then properly distributed on the slowly moving bed of the sintering machine. Here it will be subject to heat, which followed by an air blast begins the process that fuses the mixture of coke and ore into a hot clinker-like mass.

A rotary cooling bed 46 ft in diameter will catch the sintered material as it comes from the machine. The red-hot material will be allowed to cool slowly, and then removed from the cooling bed by a mechanical rake to a loading hopper and transferred into railroad cars for shipment to ore loading docks.

A somewhat similar product will be made in the nodulizing kiln, where a combination of heat plus the rotating action of the kiln will produce egg-sized lumps of the fused ore fines. This brick-lined kiln, which will also be one of the largest in regular use, will be about 12 ft in diameter and 350 ft long. The ore fines will first be mixed in pug mills and fed into the end of the rotating kiln, which will be heated to high temperatures by pulverized coal burners. Under heat, the ore fines form into nodules which will be discharged from the kiln, cooled by an air blast, and transferred to a shipping bin for loading into railroad cars.

In addition to the quantities of ore to be processed, full time operation of the plant will require approximately 50,000 tons of coke, 35,000 tons of coal and 35,000 tons of limestone annually to produce a finished product.

Oliver plans to operate the plant on a 24-hour daily schedule, and at this rate its capacity will be approximately one million tons of sinter and nodules annually. The products from this experimental plant will be the subject of much testing to determine their handling and shipping qualities as well as their behavior in the blast furnaces, Mr. Elstad states, and the operation will furnish necessary information for larger production plants of the future.

LARGE FRENCH ORDER GOES TO ELLIOTT

▲ One of the largest orders for electrical equipment ever placed in this country by the French steel industry is currently being completed by the Elliott Co. of Jeannette, Pa., at their Crocker-Wheeler division at Ampere, N. J. This equipment will drive what will be the fastest merchant bar and rod mill in western Europe, located at the Homecourt works of the Companie des Forges et Acieries de la Marine et d'Homecourt.

The details of the transaction which is financed by private funds and not by E.C.A. were completed by Parsons & Whittemore, Inc., of New York through their Paris office.

The control equipment is being furnished by the Clark Controller Co., of Cleveland, Ohio.

The Homecourt works are located in the Orne Valley a few miles from Briey, the center of the iron ore basin of Lorraine. This plant is a completely integrated one including power plant, mine, coke ovens, blast furnaces, open hearth furnaces, basic-bessemer converters, slabbing and blooming mills, continuous billets and sheet bars mills, plate mills, universal mill in addition to the many other necessary functions of a mill of this size.

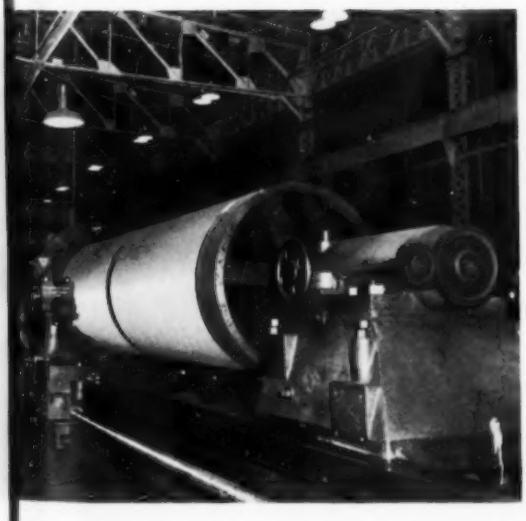
The new rod mill, being erected at a cost of $5,500,000, will eventually have an annual production of approximately 160,000 tons of finished products.

WAGNER ELECTRIC ADDS TWO NEW SALES OFFICES

▲ Two additional electrical division sales offices have been established by Wagner Electric Corp., bringing the total number of offices maintained in the United States to thirty. The New Orleans, La., office, a sub-branch of St. Louis sales under the direction of N. G. Alvis, is located at 227 International Trade Mart. The Davenport, Ia., office, located in the Kahl Building, is under the direction of S. R. Snyder and is a sub-branch of Chicago. The two additions will provide more convenient field engineering service for users of Wagner electrical apparatus in these areas.

USE THE ENGINEERING MART

GIANT HOIST DRUM



Turning the grooves in a giant hoist drum at Cleveland Crane & Engineering Co., Wickliffe, Ohio. Made of a solid one-piece steel casting, the drum is 15 ft-0 in. long by 48 in. diameter and weighs 22,300 lb. It will lift 200 ton loads and be used on a Cleveland crane in a power house.

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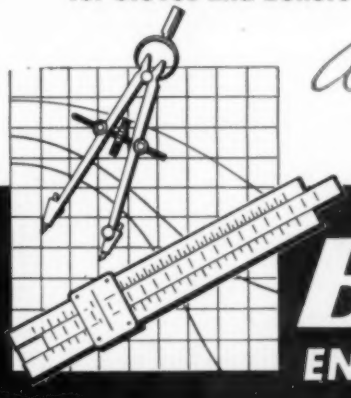
ENGINEERED COMBUSTION EQUIPMENT

for Steel Mills and Industrial Furnaces

Bloom Engineering Company designs and manufactures combustion equipment for steel mill and industrial furnaces. The correct application of these products is an important part of our service to customers.

- Long Flame Gas Burners
- Hot Air Burners
- High Pressure Fuel Oil Burners
- Nozzle Mix Burners
- Tempered Flame Burners
- Raw Producer Gas Burners
- Bloom-Paulsen-Steinbart Blast Furnace Gas Burner for Stoves and Boilers
- Low Btu Gas Burners for Galusha Producer Gas, Blast Furnace Gas, Mixed Gases
- Differential Pressure Constant-Flow Oil Valves
- Steam-Oil Pressure Ratio Regulator
- Bloom Time Cycle Reversal Systems for Open Hearth Furnaces



Write for bulletins on any of the above Bloom Equipment.

BLOOM ENGINEERING CO., INC.

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High Strength

for reduction of

STAINLESS, HIGH SPEED and AIRCRAFT QUALITY STEELS

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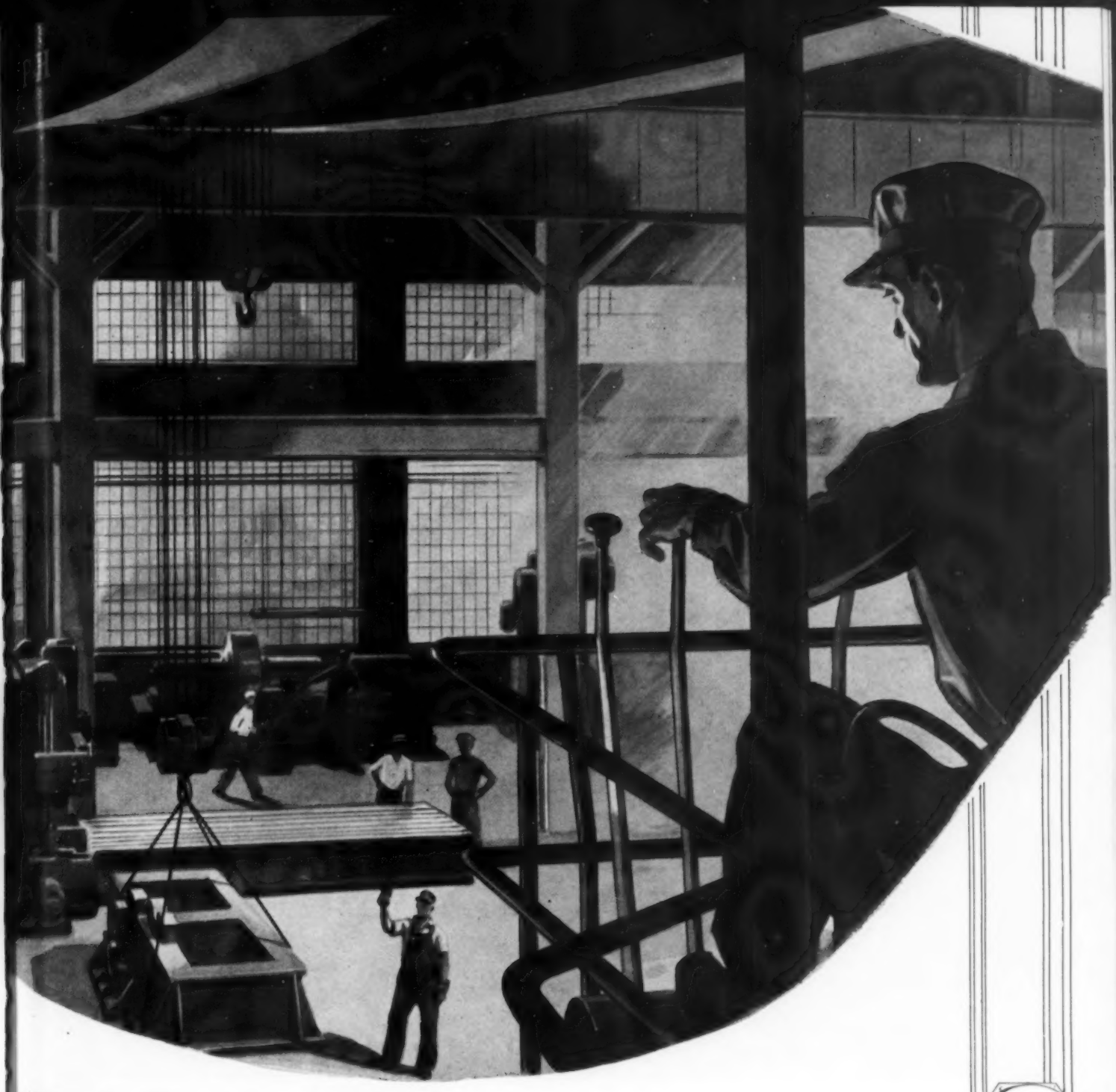

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When you buy a crane, you want dependable service for many years to come. Your P&H "Job Engineered" crane will be built to meet your requirements to insure dependability . . . ample reserve capacity . . . adequate service factor . . . maximum safety. All P&H electrical equipment is designed and built by P&H for crane service — not adapted for it.

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*T. M. of Harnischfeger Corporation for electro-magnetic type brake.

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WHEREVER metals are cleaned, plated or coated, "Karbate" impervious graphite equipment is an ideal material for cooling, conveying, pumping or storing the corrosive fluids involved.

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"National" carbon brick are the time-tested standby in handling nitric-hydrofluoric acid solutions . . . such as are used in the pickling tanks shown above. For complete information on both "Karbate" impervious graphite, and "National" carbon brick, write to NATIONAL CARBON DIVISION, Union Carbide and Carbon Corporation, Department IS.

These products sold in Canada by Canadian National Carbon Company, Ltd., Toronto 4

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Personnel News...

F. M. Rich, who has been vice president of the Kaiser Steel Corp. in charge of operations at Fontana, Calif., has been appointed general superintendent of the Indiana Harbor, Ind., works of Inland Steel Co. Mr. Rich succeeds **F. M. Gillies,** works manager, and **A. P. Miller,** general superintendent, both having retired. Mr. Rich, a graduate of the University of Illinois in mechanical engineering, is a veteran of the steel industry and is well known to Chicago. Following his graduation from Illinois in 1925, he was employed until 1929 at the South works of the Carnegie-Illinois Steel Corp. In the latter year, he joined the Wisconsin Steel Co. in Chicago as assistant superintendent of the open hearth department, but soon left to become general foreman of the blast furnace department at the Campbell works of the Youngstown Sheet and Tube Co. until 1934.

During 1934 and 1935, he was assistant superintendent of blast furnaces at the Youngstown plant of the Republic Steel Corp., then was transferred to Buffalo as superintendent of blast furnaces at that company's Donner plant. He served there until 1938, when he became assistant to the vice president in charge of operations at the Steel Co. of Canada, Hamilton, Ontario.

From 1942 to 1946, he was assistant works manager of that company at its Hamilton works. He left the Canadian firm in 1946 to join the Kaiser Steel Corp.

George B. McMeans was appointed works manager and **Edward J. Duffy** as general superintendent of the Kaiser Steel Corp. plant at Fontana, Calif. Mr. McMeans succeeds **F. M. Rich,** who resigned to take a position with Inland Steel Co., and Mr. Duffy succeeding Mr. McMeans as general superintendent.

Mr. McMeans started to work at the age of 16 in mills in the Pittsburgh, Pa., area, during summers while acquiring a technical education. He worked for Allegheny Ludlum Steel Corp. in the iron foundry, steel foundry, and open hearth and electric furnace department, during successive summers while attending Lehigh University. He interrupted his university preparations for a career in metallurgical engineering for one year to work in the inspection department at Allegheny in the strip, cold rolling and alloy sheet mills. Mr. McMeans, upon graduation in 1935 from Lehigh University, started general engineering training in all departments of John A. Roebling's Sons Co., Trenton, N. J., where he rose rapidly in the blooming mill, rod mills, metallurgical department and open hearth, becoming superintendent of the open hearth and hot mills division in 1942. Mr. McMeans in 1947 joined the Kaiser Fontana plant as assistant general superintendent. In November 1948 he became general superintendent.

Mr. Duffy is a veteran of 30 years in the iron and steel industry. Upon graduation from high school, he went to work in May 1919, with Carnegie-Illinois Steel Corp. at Duquesne works, Duquesne, Pa. He held various supervisory jobs in the blast furnace department of that plant, and remained there until December 1942, when he joined Kaiser as assistant superintendent of the Fontana iron production division and was employed in that capacity until his promotion to superintendent of the iron production division. In January 1948, he was transferred temporarily to the Kaiser-Frazer Parts Corp. as manager of the blast furnace division, Provo, Utah, to start up and operate the iron producing plant there. He returned to Fontana last year as assistant general superintendent.

John Lawrence was appointed to the newly created post of technical vice president of SKF Industries, Inc., Philadelphia, Pa. Mr. Lawrence will have charge of all manufacturing, engineering and research operations in the firm's plants in Philadelphia and Shippensburg, Pa., and Hornell, N. Y. He joined the Philadelphia company in December, 1944, as factory manager after having served in a similar capacity at Jones & Lamson Machine Co. of Springfield, Vt.

Carl O. Roeder has been named southern district manager for Brooks Oil Co. With headquarters in Birmingham, Ala., Mr. Roeder will direct Brooks sales and engineering activities in all southern states east of the Mississippi. Before joining the Pittsburgh and Cleveland oil company, Mr. Roeder had been associated for 20 years with the Farvel Corp. as a lubrication sales and engineering specialist. From 1937 until 1940 he served as Farvel's British representative with headquarters in

F. M. RICH

EDWARD J. DUFFY

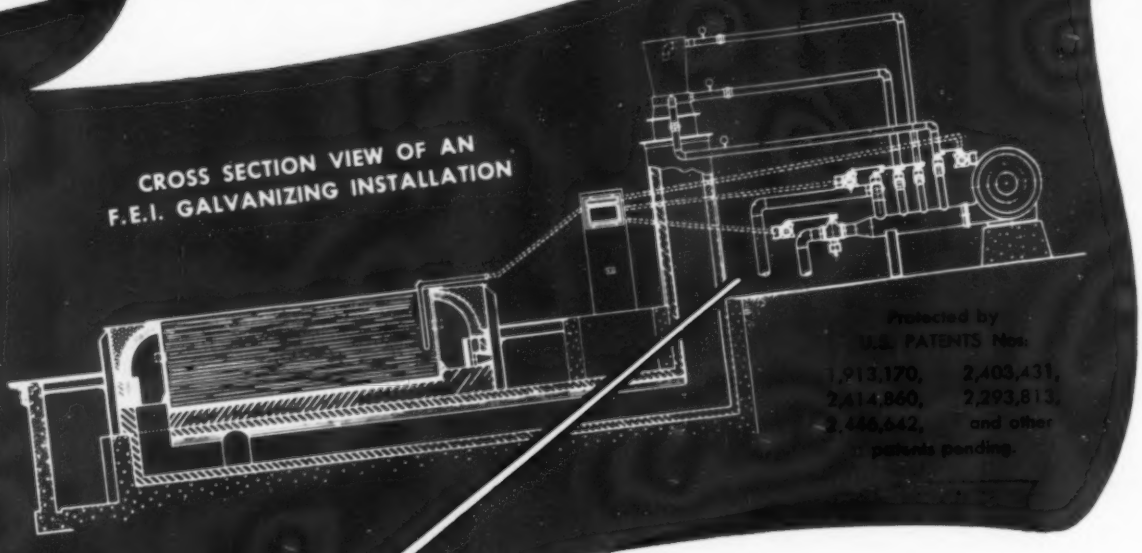
JOHN LAWRENCE

CARL O. ROEDER

3 REASONS WHY

F·E·I controllable exhaust system

IMPROVES PERFORMANCE



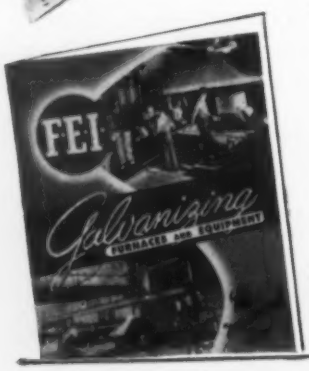
...in Galvanizing

SHEETS—TUBES—METALWARE

SPEEDS UP PRODUCTION! Automatic OPERATING CONTROL regulates heat input and exhaust simultaneously . . . The required temperature is reached *faster!*

SAVES FUEL! *Automatic* HOLDING CONTROL holds uniform temperature on *minimum* gas flow, after the desired operating temperature has been reached. Cuts cost of production.

PROLONGS KETTLE LIFE! *Automatic* LIMITING CONTROL limits temperature during periods of low heat requirement and sudden shutdowns. Actual records show kettle life more than doubled or even tripled. Get all the facts . . . how the F.E.I. Controllable Exhaust System has really modernized galvanizing technique.



Write for Bulletin

F E I Furnace Engineers, Inc.

F. E. I. Building • 1551 West Liberty Avenue • Pittsburgh 16, Pa.

3

London. Prior to joining Farvel he did engineering work with Toledo Railways & Light Co., Clarage Fan Co., and Baker Brothers Machinery Co.

R. O. Bridge was named purchasing agent for Crucible Steel Co. of America, and **C. C. Kennedy** as assistant purchasing agent. Both are stationed in Pittsburgh, Pa., where Crucible purchasing activities are centered.

Leonard C. Pietsch was appointed superintendent of the sheet mill and galvanizing department of the Inland Steel Co. at Indiana Harbor, Ind. Mr. Pietsch, formerly superintendent of the 10 and 14-in. mills, replaces Howard W. Bradley, who resigned. **John G. Rothfuss** will remain as an assistant superintendent in the sheet mill and galvanizing department, and **Robert W. Rost,** formerly a shear foreman, will serve also as an assistant superintendent under Mr. Pietsch. **Robert S. Gentz,** assistant superintendent in the 10 and 14-in. mills, moves up as superintendent of those mills.

L. A. Grasso has been put in charge of industrial sales for the Western Pennsylvania zone of Texas Co., with headquarters at Coraopolis, Pa. He succeeds **H. E. Ennis** who goes to Philadelphia to supervise Industrial sales for southeastern Pennsylvania. Mr. Grasso is a native of Johnstown, Pa. He was graduated from the University of Pittsburgh in 1936. Previously, he has been associated with Jones & Laughlin Steel Corp. and Carnegie-Illinois Steel Corp.

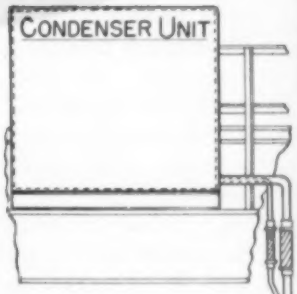
Donald K. Rennie has been appointed works manager of American Brakeblok division of American Brake Shoe Co. at Detroit, Mich., and **James W. Green, Jr.** has been appointed superintendent of Brakeblok's Winchester, Va., plant.

CHICAGO HONORS PAST CHAIRMEN

The March 7th meeting of the AISE Chicago district section honored the past chairmen of the section with a past chairmen's night. Twenty of the past chairmen who helped to start the section, and who have served it over the years were gathered together at the U-shaped table shown in the photograph. Among the past chairmen at this table can be seen H. G. Hague, W. A. Perry, H. R. Zimmerman, W. J. Tunny, K. E. Dinius, Pete Williams, Warren S. Hall, J. F. Headlee, P. E. Thomas, A. B. Glover, A. R. Dibbens, J. H. Miller, R. J. Beeswy, John Wagner, Gordon Fox, L. A. Wynd and H. R. Middlebrook. At the meeting S. L. Jameson of the General Electric Co. presented a paper on "Ventilation of Steel Mill Motors and Motor Rooms."

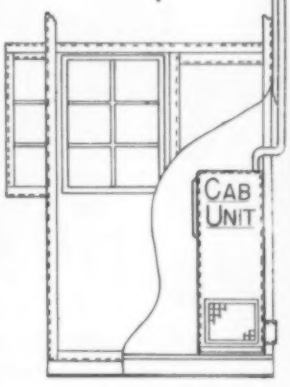
LINTERN Aire-Rectifiers

SOON REPAY OUTLAY... PROVIDE MANY LASTING BENEFITS



By providing normal, healthful working conditions, Lintern Aire-Rectifiers have always paid out in dollars and cents. But now — with the big cut in over-all costs, the outlay is even more quickly paid back — in improved material handling, better crane operation, and less labor turnover.

3 MODELS FOR NEW *or* EXISTING CRANES . . .



These three models come in the new "split" design and offer many economies. Due to elimination of troublesome, clumsy air ducts, installation has been greatly speeded up. Flexible in location, the new models are easily and quickly installed on existing cranes as well as on new ones. The three sizes meet all needs and allow us to give you the lowest cost unit to meet your individual needs. In addition, we have a new self-contained Aire-Rectifier for location in cab where conditions permit its use.

May we explain the features and economies of the Aire-Rectifier as applied to your particular conditions? Ask for Bulletin A.C. 4912.

THE LINTERN CORPORATION

54 LINCOLN AVENUE BEREA, OHIO

William E. Clark was named general manager of the engineering works division of Dravo Corp., Pittsburgh, Pa., and his election as a member of the executive committee was also announced. Mr. Clark became identified with Dravo in 1930 as assistant to the manager of the Keystone Sand & Supply Co., one of the pioneer Dravo companies. During the war, he was administrative manager of Dravo's shipyard at Wilmington, Del., important facility for constructing vessels for the armed forces. Since his return to Pittsburgh in 1945, he has been general manager of the company's Keystone division. His successor as general manager of the Keystone division is **Louis P. Struble, Jr.**, who has been with Dravo since 1935. For the past five years Mr. Struble has been distribution manager of the Keystone division.

John D. Cook was appointed as a representative for Kennametal, Inc., in the northern Indiana area. The following other additions to the Kennametal service personnel have been made: **William J. Bruun,** Chicago office; **Harry E. Brandvik,** Chicago office; **Edward J. Novack,** Philadelphia office.

H. E. Maser, Grant Building, Pittsburgh, Pa., has been appointed representative of Kerrigan Iron Works, Inc., of Nashville, Tenn., manufacturers of Weldforged steel products, including grating and stair treads, street light standards, flagpoles and bleachers.

A. G. Hendrickson was appointed assistant sales manager of the P&H welding division at Harnischfeger Corp., Milwaukee, Wis. Mr. Hendrickson has had many years of experience with P&H, serving for five years as welding engineer in the Milwaukee and the Minneapolis territories.

Robert E. Savage and **Ralph W. White** have recently joined the magnesium-containing cast iron section of the development and research division of International Nickel Co., Inc., at New York. They will make their headquarters in New York and will work on the new ductile iron recently announced by the company.

Robert J. Stoup was named plant metallurgical engineer at the Ambridge, Pa., plant of the Spang-Chalfant division of National Supply Co. Born in Pittsburgh, Pa., Mr. Stoup graduated from the University of Pittsburgh in 1931 with a degree in metallurgical engineering. He joined the National Supply Co. in 1936 as assistant metallurgist in the research department of Spang-Chalfant. Until his recent promotion he was in charge of heat treating and production at the company's Carnegie, Pa., plant.

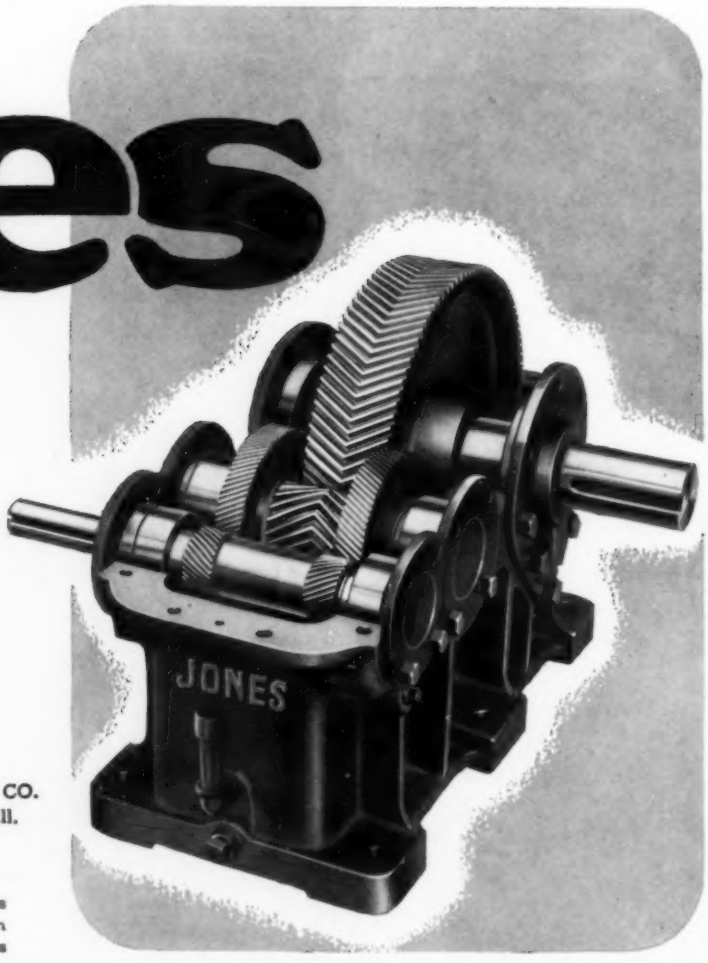
Robert H. Davies was elected vice president and acting general manager and **Edward H. Remde** as vice president for Baker Industrial Truck division of Baker Raulang Co., Cleveland, Ohio.

Obituaries

Frank A. Luebbe, vice president and general sales manager of Nichols Wire and Aluminum Co., Davenport, Ia., died on March 9.

Jones

Herringbone SPEED REDUCERS—



. . . are built in single, double and triple reduction types. Symmetrical gear arrangement provides balanced loads on liberally proportioned bearings. Housings are substantially constructed, well ribbed and have generous pads for foot bolts.

The method of selecting these reducers with complete horsepower and dimension tables is shown in Catalog 70.

Since 1890 Jones In The Service Of Industry

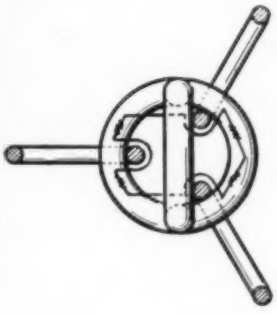
W. A. JONES FOUNDRY & MACHINE CO.
4431 W. Roosevelt Rd., Chicago 24, Ill.

Herringbone — Worm — Spur — Gear Speed Reducers
Pulleys • Gears • V-Belt Sheaves • Anti-Friction
Pillow Blocks • Friction Clutches • Flexible Couplings

the MOST ECONOMICAL

SUSPENSION CHAIN

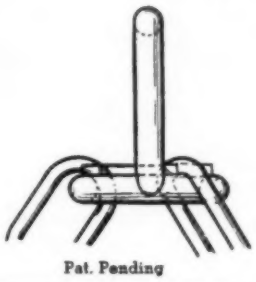
for hard, fast working magnets



Heat-treated high alloy steel PLUS the patented ring to eliminate rubbing and twisting gives Downtown Frictionless Magnet Suspension Chains up to 3 times the life of old-style suspension chains.

Locating Plate keeps magnet face level.

No more periodic annealing.



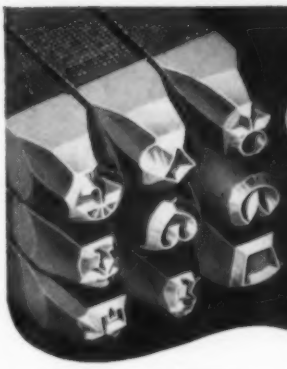
Pat. Pending

For these reasons Downtown Suspension Chains offer you best dollar value.

Each chain for 55 inch magnets is tested to 89,000 lbs. Each chain for 65 inch magnets is tested to 115,000 lbs. Don't delay! Write now for prices. Prompt shipment from stock.

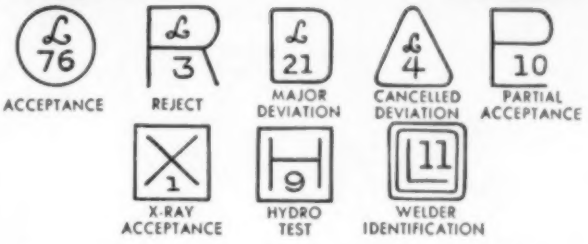
DOWNTOWN *Company*

1836 EUCLID AVE. • CLEVELAND 15, OHIO



Simplify Industrial

CODE MARKING *with* **"SAFETY" SYMBOL STAMPS**



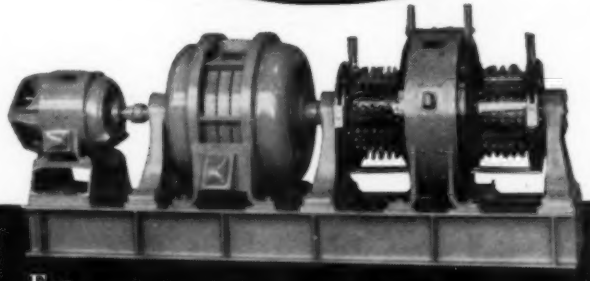
"Safety" code symbol stamps simplify inspection and piece work identification marking. Shown is a complete range of stamps for various inspection code marks. Write today for data on stock or specially designed stamps for your coding requirements.

M.E. CUNNINGHAM CO.

SAFETY STEEL STAMPS

105 East Carson Street • Pittsburgh 19, Pa.

Motor Generators by COLUMBIA



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Electroplating — Anodizing
Electrocleaning — Electropolishing

There's a Columbia M-G Set available for your needs, whether you have a small plating bath or a large continuous strip plating line. Capacities up to 20,000 Amperes; 6 Volts and up. Dependable, performance proved, for many years. Your inquiries solicited.

Write today for Catalog IS-700

COLUMBIA ELECTRIC MFG. CO.

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CRANE BUILDERS Since 1903

BEDFORD CRANES

Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
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GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

BEDFORD FOUNDRY & MACHINE CO.

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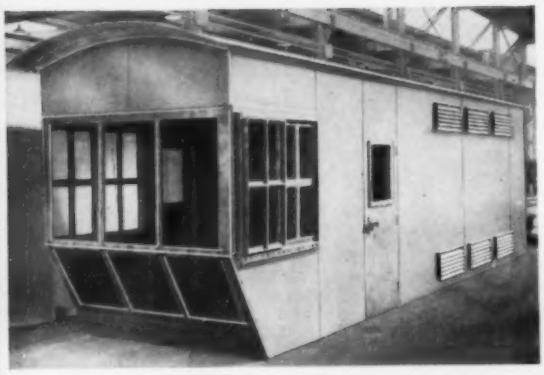
Gray
Iron
Castings



STEEL CONTROL AND REGISTER HOUSE FOR STEEL MILL

30 TON ELECTROLYTIC PLATING MILL BUILT FOR A STEEL MILL CUSTOMER

STEEL MILL ROLL TABLES

Reference File of Specialized Facilities (No. 509) sent on request.

If your steel mill building program calls for FABRICATED COMPONENTS

call BRANDT!

Electrolytic plating Tanks
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Plain or Rubber Lined
Completely Assembled
Specialized Equipment

BRANDT *measures up!*

BALTIMORE

TO STEEL MILL EQUIPMENT SPECIFICATIONS

BRANDT offers 240,000 sq. ft. of facilities for real help in solving your engineering and production problems. Help that saves time and money too! Completely equipped for fabricating any type of metal. Precision metal craftsmen since 1890, accustomed to handling a variety of specialized projects in a wide range of sizes.

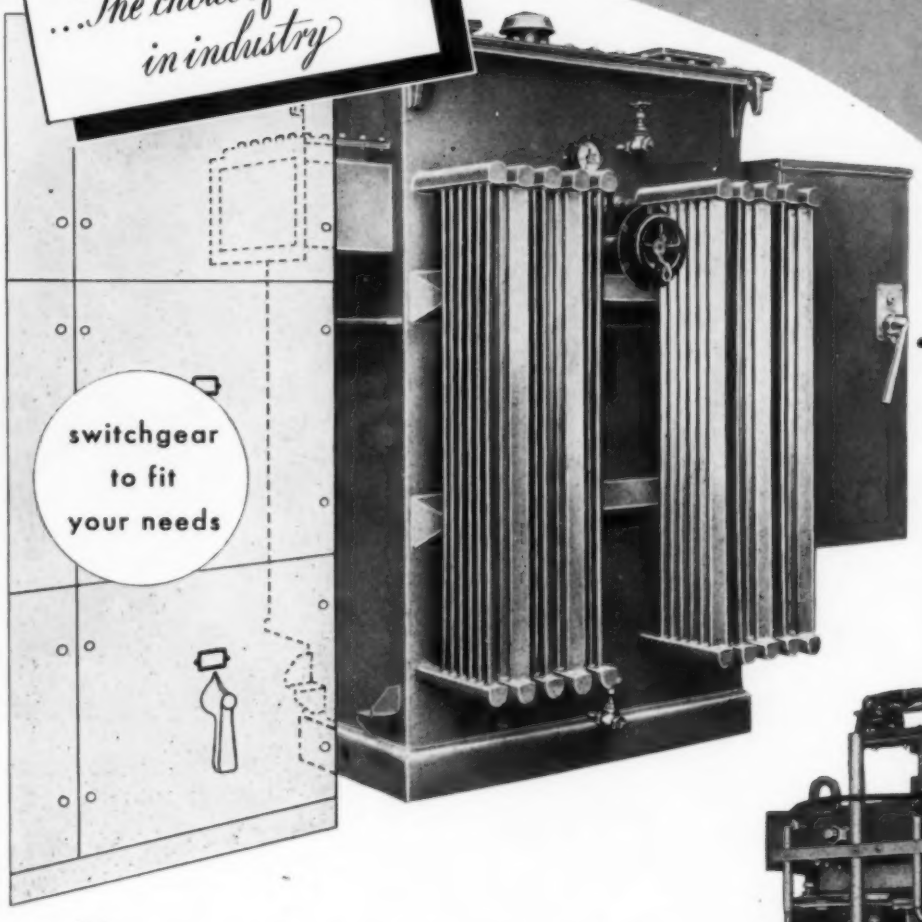
Brandt facilities are all under one roof, strategically located near steel mills, in the midst of major rail, water and highway transportation systems.

CHARLES T. BRANDT, INC. — 1700 RIDGELY ST. — BALTIMORE 30, MD.

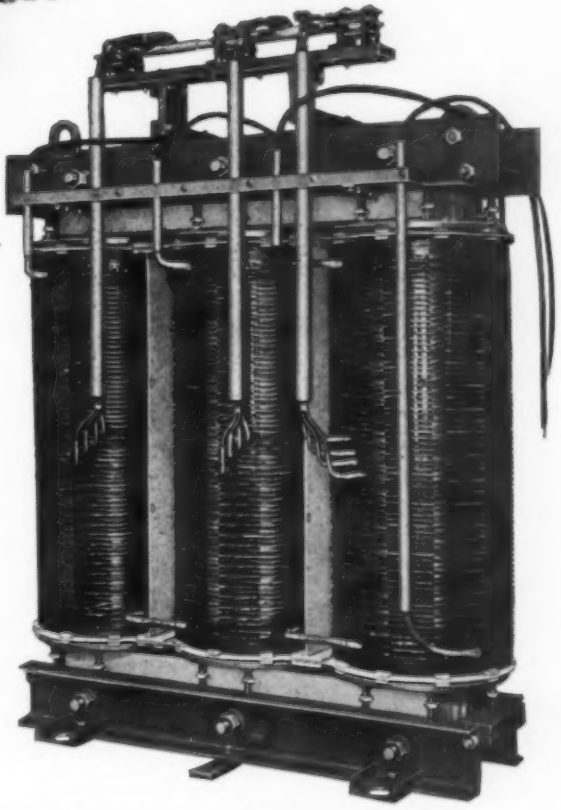
WAGNER TRANSFORMERS
...The choice of leaders in industry

Wagner Unit Substation Transformers .....

designed to meet your distribution requirements



Core and coil assemblies of Wagner unit substation transformers are designed by experienced engineers, and built and tested by skilled workers. Highest quality materials are used throughout, and meticulous attention to detail marks each step in their construction.



The transformer is the vital part of a load center distribution system. If the transformer fails, the entire system is dead whereas only part of the distribution system is affected by the failure of a switch or circuit breaker.

You can be sure of a dependable continuous flow of power from a Wagner transformer and you can be sure that it has been carefully designed to meet your distribution requirements.

Wagner unit substation transformers with incoming high voltage switch sections to meet your requirements, and with proper throats on the secondary side to connect to any make of switchgear, are available in the usual range of ratings up to 2000 kva. Our factory-trained sales engineers are well qualified to recommend the various combinations necessary to handle your unit substation requirements and they will be glad to give you immediate service.

Wagner unit substation transformers have been installed in all kinds of industrial plants including synthetic rubber, petroleum, steel, chemical, aircraft, automotive, paper, and many others. The importance of the transformer in a unit substation justifies calling in the Wagner sales engineer to help solve your load center problems.

Bulletins TU-13 and TU-56 describe the design and construction features that make Wagner liquid-filled and dry-type unit substation transformers outstanding.

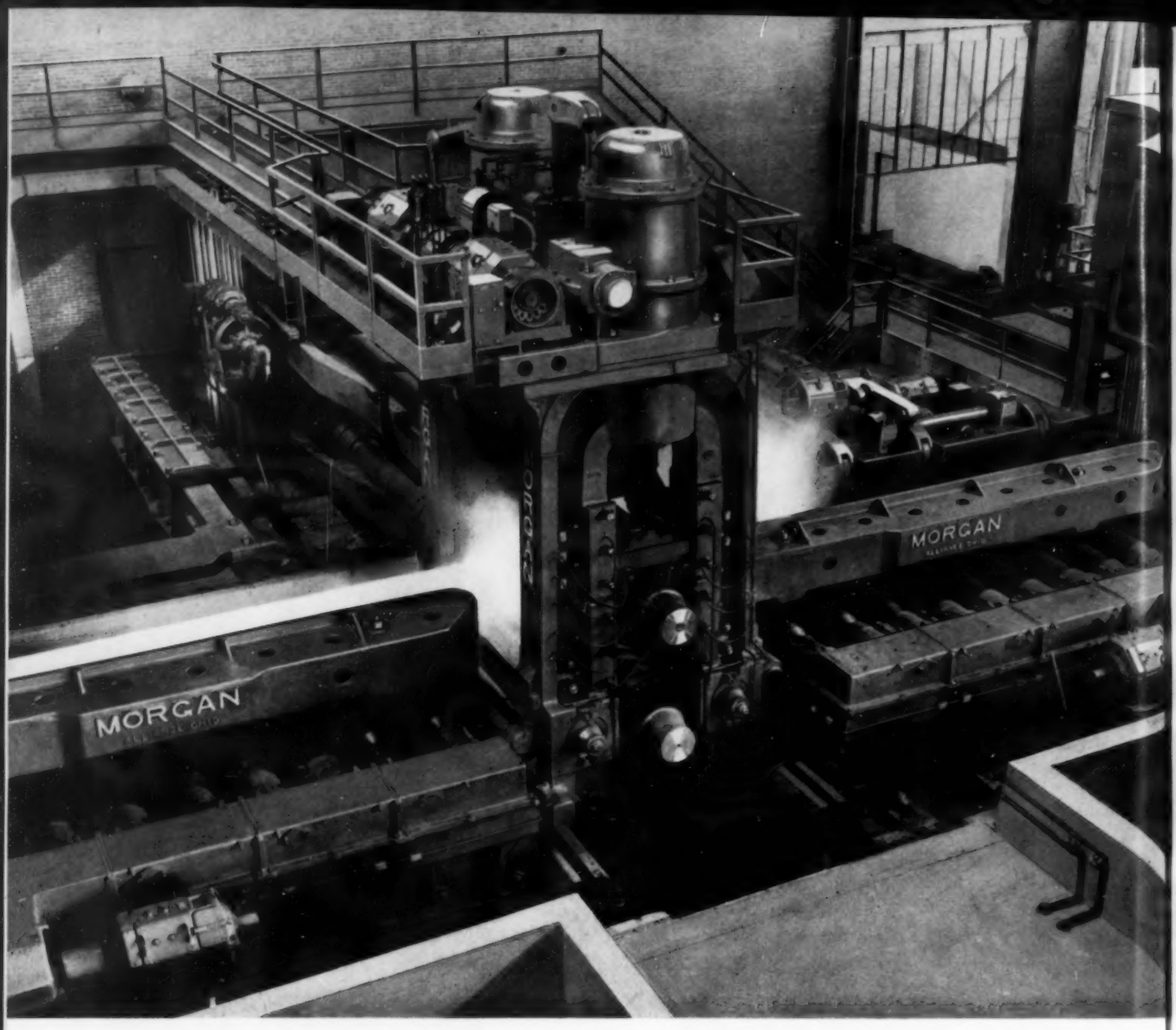
WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

Wagner Electric Corporation
EST. WE 1891

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 29 PRINCIPAL CITIES

T50-4A



Morgan 40″ — 2 High Reversing Blooming Mill direct connected to two 3000 Hp. 40/100 Rpm. motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box section type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

sign and build mills and mill machinery for the steel industry. For your next mill and equipment, consult—

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HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

DEVELOP MAGNETIC SEPARATOR TO AID CONCENTRATION OF LOW GRADE ORE

▲ An improved type magnetic separator, to aid in concentrating low grade iron ore from Minnesota's famed Mesabi Range, has been developed by Jeffrey Manufacturing Co. of Columbus, Ohio, with magnetic design assistance from the Westinghouse Electric Corp., East Pittsburgh, Pa. The new device is part of a long-term project to assure the nation of ample domestic ore supplies after Mesabi's high grade ore is used up.

Phelan McShane, consulting mining engineer for Westinghouse, disclosed that the new ore separator operates on a somewhat different magnetic principle than previous devices of its type.

The new separator consists of a rotating drum mounted in a pulp box of special design. Stationary magnets inside the drum provide the means whereby iron ore is extracted from the taconite, a formation of 25 per cent iron and 75 per cent rock.

"As the mixture passes beneath the separator's rotating stainless steel drum," Mr. McShane explained, "the magnets draw the magnetic iron ore from the mixture to the drum. The movement of the drum carries the ore through a washing zone and then away from the direct pull of the magnets, depositing it in a trough leading to further grinding stages."

The entire magnetic separation process calls for grinding the taconite in stages, passing the partially-ground ore through the new separator between grinding stages in order to eliminate barren rock from the system. Then the finely-ground material mixed with water is passed through another type of Jeffrey magnetic separator in order to make a final separation of the iron mineral from the ore. The final product is dewatered on filters and ultimately is processed into small round lumps of ore, called nodules.

Mr. McShane disclosed that this system is already at work in the Aurora, Minn., plant of the Erie Mining Co., helping extract iron ore from magnetic taconite. The ore nodules produced contain about 64 per cent iron, which is several per cent higher than the high-grade ores now used in blast furnaces. Economies in shipping and in blast furnace operations made possible by this richer ore are expected to offset the added cost of extracting the iron mineral from the taconite.

These ore nodules already are being produced at the Aurora plant at the rate of 200,000 tons a year. The steel industry expects the production figure to be raised to equal present ore output by the time the Mesabi's high grade ore is exhausted.

CABLE FAULT LOCATOR USES IMPULSE VOLTAGE

▲ The high-voltage d-c impulse transmitter with pickup coil and pointer indicating detector comprising a new impulse cable fault locator were designed primarily for locating faults on lead-covered cable installed in ducts. The latest equipment has applications also on aerial and buried cable, and has proved highly effective in utility and industrial service.

This cable fault locator can be used on both aerial and buried cables.

The Biddle impulse cable fault locator was developed on the property of a large eastern utility company and incorporates the experience and resourcefulness of engineers who have learned that there is no magic in locating cable faults.

In operation the set is essentially independent of the type of fault or its apparent resistance, and depends only on the impulse voltage required to break down the fault.

The Model 2-2 Fault Locator, illustrated, is rated up to 20 kv with a discharge capacitance of 2.5 muf, for use on all cable up to 15 kv and higher. The set requires only about 500 watts to operate, from a 115-v source of high voltage d-c for proof testing on all types of electrical equipment.

GREASE ABSORBENT HAS INCREASED ABSORPTION

▲ A new, improved oil and grease absorbent called Carey "Asbesto-Sorb" is now on the market. The absorbent produced before the war, has returned with a higher quality asbestos fiber content and an 11 per cent to 16 per cent greater oil absorption property than competitive materials subjected to Gardner-Coleman tests. It is classified as non-combustible by Underwriters' Laboratories, Inc., and may be used to retard the spread of fire.

"Asbesto-Sorb" has been specifically developed to quickly and easily remove oil and grease wherever they accumulate and constitute an undesirable hazard or appearance. It is available in 50 lb cartons, contains no acids or caustic and can be reused until thoroughly oil soaked.

TRACER-CONTROLLED LATHE SPEEDS SHAFT TURNING

▲ Designed and engineered specifically to provide fast, repetitive shaft-turning at low cost, a new tracer-controlled method is announced by the Monarch Machine Tool Co.

This newest contribution to the applied machining art of tracer-controlled duplication, known as the "Monarch Motor-Trace," is applicable to all Monarch engine lathes 14 in. and up to and including the 20 in. Model M. It is a motor-powered, electrically-operated duplicating device which converts any new Monarch machine within these sizes into an automatic-cycle unit capable of producing small lots of two or three pieces with the economy ordinarily asso-

ciated only with long production runs.

Combining war-born developments in electronic controls with the basic, performance-proved principles of automatic sizing lathes pioneered and patented by Monarch some 20 years ago, this duplicating attachment incorporates numerous refinements that increase productiveness and improve accuracy.

Tracing with the Motor-Trace device is from gage blocks, micrometer heads or a template, thus making the unit readily adaptable for handling straight, multiple-diameter shaft-turning requirements in any desired size within the normal capacity of a Monarch machine equipped with this attachment. Also, it may be used for step-boring and step-facing; and when tracing is from a template, such work as tapers, contours, radii or chamfers may be turned.

With finger-tip control of the automatic-cycle from a single pedestal type station, one operator on most work can handle two machines with less fatigue than he would operate one manually-controlled lathe. Equally important, the Motor-Trace can be disengaged in 30 seconds or less, so that the machine can be quickly converted from automatic-cycle to conventional engine lathe operation. Application of the attachment in no way reduces the lathe's normal swing capacity.

POWER UNITS EMBODY MANY IMPROVEMENTS

▲ Ready-Power gas electric power units, widely used in electric industrial truck operation, now embody new improvements and refinements designed to reduce maintenance and to provide more economical operation. The new features will appear first on a new general purpose unit which is rated at 36-48-60 or 72 volts for use with 4000 lb fork trucks, 10,000 lb platform truck and 6000 lb crane trucks.

According to the company announcement the new model employs tubular flange type, flexible engine mountings, to eliminate strains being transmitted from the frame of the unit to the engine with resultant breakage and oil leaks, also a flexible oil drain line. Arrangements have been made so that present users can adapt these two improvements readily to existing Ready-Power Model H units.

Other features built into the new model include an oiler for the governor which permits cleaning without disassembly; the oil filler and breather unit located on the cylinder head where it can be reached easily; combination fuel pump and filter; and improved muffler design. The cooling fan, which is in a stationary position, has improved shrouding for quietness and greater efficiency. With this arrangement, fan belt adjustment is accomplished by moving the 6-volt battery charging generator. A new water pump is gear driven with larger bearings and improved rotary seal. Distributor drive is incorporated in the water pump drive. The fuel tank which was formerly located inside the unit housing now is a completely separate tank which is fitted into a recessed area on the outside of the unit housing. Overall shape and dimensions of the unit remain the same.

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

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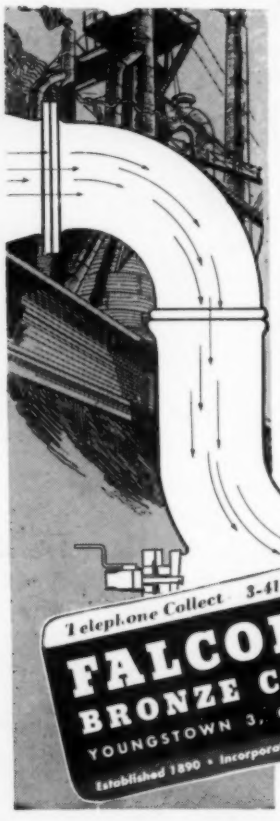

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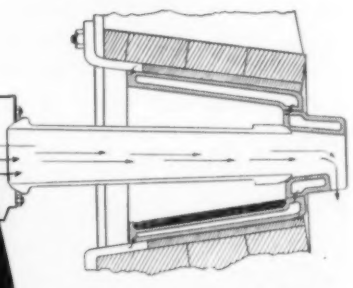

Telephone Collect 3-4186
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YOUNGSTOWN 3, OHIO
Established 1890 • Incorporated 1895

Illustrated is an installation of Falcon-produced Kinney Refractory-Lined Tuyere Cooler, U. S. Pat. App. Serial 530153, and Holzworth "Split Nose" Tuyere, U. S. Pat. 1,789,870.

CASTABLE REFRACTORY IS PLASTIC AND WORKABLE

▲ A new lightweight refractory has been developed by Harbison-Walker Refractories Co. Known as H-W 56 lightweight castable, it combines lightness in weight with unusually high strength and insulating values, according to the manufacturer.

Weighing only 56 lb per cu ft, the lightweight castable refractory has a thermal conductivity 65 per cent less than that of high-duty fireclay brick. Good strength and volume characteristics are claimed throughout the product's entire working temperature range, and it may be used safely in temperatures up to 2000 F. This new refractory is plastic and workable, and it can be cast in place, troweled or gunited with equally good results.

The new castable is lighter than water and, with the skin surfaces sealed, will float. It is packaged in moisture-proof sacks containing 56 lb of material, the exact amount required for one cu ft of construction.

This new Harbison-Walker refractory is recommended for furnace walls, boiler settings, special shapes, tube decks, ducts and breeching linings, domestic furnaces, furnace door linings and oil refining units.

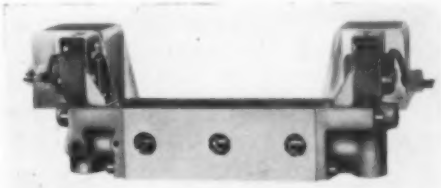
TRAVELING SOLENOIDS USED IN NEW VALVES

▲ Known as the type "DS" line, these new "Quick-as-Wink" valves employ small solenoids traveling through only an ⅛ in. stroke to move a small pilot valve plunger to apply air to the operating piston to move the main valve plunger back and forth. When the solenoid is deenergized the pilot cylinder is exhausted through the small pilot valve.

The design assures positive performance and a much greater operating force than is possible with a large direct connected solenoid.

The reduced amperage requirement of the small short stroke solenoid permits operation with standard types of pilot switches, avoiding intermediate relays and simplifying the electric control circuits.

Since the solenoid plunger and small pilot cylinder weigh only a few ounces—and have very short travel—the valves can be operated at very high speeds—at normal pressures—and consequently are specially suited for use with certain production welders and other high cycle machine requirements.



The design assures positive performance and greater operating force.

The inertia of the solenoid and pilot valve is much less than in direct connected solenoid designs, avoiding destructive impact and reducing the possibility of solenoid trouble resulting from voltage variations.

Housing and all internal parts, except the packing, are brass or bronze. Plungers and operating pistons are stainless steel.

Clean big parts with the Oakite Steam Gun!

HERE'S an easy way to clean metal parts that are too large to be soaked in tanks or conveyed through washing machines.

Just use the Oakite Solution-Lifting Steam Gun to apply Oakite cleaning solution under 40 pounds pressure. Dirt disappears quickly, leaving parts ready for assembly, further machining, pre-paint treatment, etc. (Same gun applies Oakite paint-stripping solutions.)

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GAS-FIRED MACHINE FOR HEAT TREATING

▲ Heavy-duty chisels are hardened and drawn in local sections of both ends, at the rate of sixty per hour on an automatic gas-fired machine produced by Selas Corp. of America.

Chisels are hand loaded to guides on two turntables and held in position by tension arms. The hydraulic indexing movement of the turntables carries the chisels through seven stations: first, heated by two open burners; second, quenched and hardened by two oil streams; third and fourth, oil washed off by two water streams; fifth, drawn by two open burners; sixth, cool; seventh, unload.

After one chisel-end has been treated in the cycle of the first turntable, the chisel is reloaded to the second turntable, moving in the opposite direction, for similar treatment at the other end.

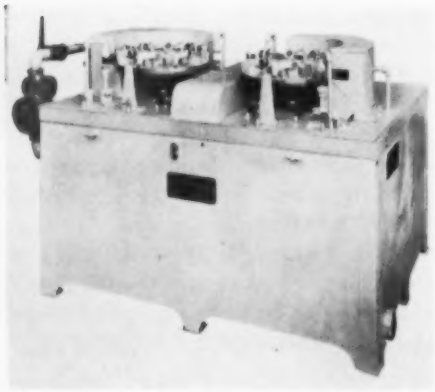
The machine includes an oil-recirculator and heat exchanger. The oil wash water is returned to a separator tank for reclamation of oil.

Variable speed control provides for changes in heating time, if required for size change. The fuel consumption is approximately 60 cu ft of 1000 Btu gas per hour.

Correct combustion mixture of gas and air is supplied at constant pressure to the machine by a Selas combustion controller. Installations are equipped with Selas fire checks.

The machine is adaptable, as to size and shape of pieces requiring localized heat treatment.

The machine is adaptable as to size and shape of pieces requiring localized heat treatment.



THERMO-SETTING RESIN ADHERES WITHOUT PRIMER

▲ Electro Chemical Supply & Engineering Co. announces an entirely new and different type of thermo-setting resin used as an acid and alkali-proof cement or coating, called "Duron."

The resin is remarkable in that it will adhere without the use of a primer to concrete or metal, and is self-hardening at room temperature. The novel adhesive properties are due to the fact that, unlike thermo-setting cements and coatings heretofore produced, the new product is not derived from phenolic or furfuryl alcohol resins.

The resin is used in the manufacture of acid and alkali-proof cements for joining brick and tile, as a coating for concrete, steel, or wood, and as an impregnant for wood. Useful materials may be produced by mixtures with metal powders, asbestos, cork and other insulating materials.

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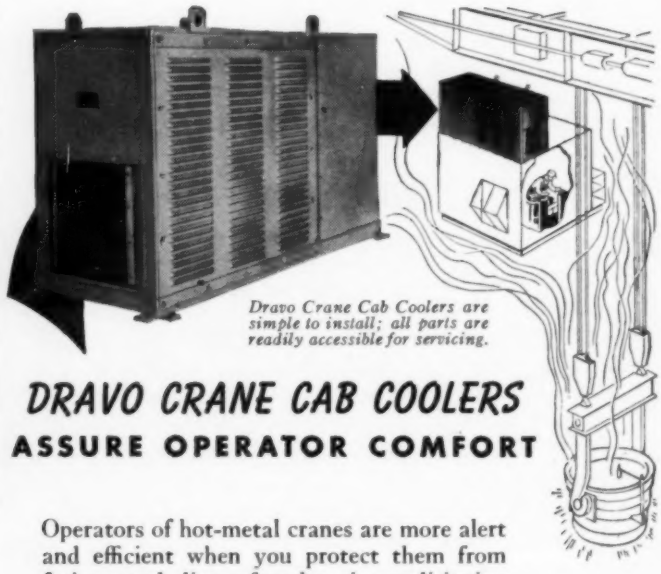

Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.

DRAVO CRANE CAB COOLERS
ASSURE OPERATOR COMFORT

Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.

Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:

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Fume and Odor Removal	Dehumidifying
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Here is an example of the new in rolling mill design . . . in tune with the need for high production, high accuracy and low conversion costs.

This mill is in operation at the Minnequa Works of the Colorado Fuel & Iron Corporation. It is the 38th Morgan continuous rod mill—the 196th Morgan mill—built since 1888.

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(1) Plant-Wide Flow Measurement

Described and illustrated in a new booklet are three basic units in standard pipe tees plus indicating, controlling, recording or telemetering instruments which provide complete plant-wide flow measurement. Flow rates from 2 to 6200 gpm and from 3 to 12,500 cfm are handled with a minimum number of basic metering parts designed for installation inside standard pipe fittings. Mountings for indicators, controllers, recorders, integrators and telemetering instruments are interchangeable in all sizes. Suitable for liquids, gases, pulps and slurries, these RATO-SLEEVE meters permit plant-wide flow-measurement standardization at low cost. (83). Fischer & Porter Co.

(2) Hydraulic Presses

A new 28-page bulletin on the use of hydraulic presses for sheet metal working industries has just been issued. With the development of new operating controls, improvements in the pressure generating systems, new frame designs, and better lubricating methods, it is believed that these hydraulic presses now provide increased production with fewer rejects in many sheet metal operations. The bulletin points out features of Birdsboro hydraulic presses which contribute to better performance in drawing and forming, coining and embossing, and blanking and piercing operations. Frame types and sizes of various press models are described, and tables are given for standard frame sizes, and operating speeds on single action and double action presses. The bulletin is an outline of the advantages of hydraulic presses for the various types of metal stamping operations and a guide to the selection of the appropriate size and type of press. (C-1A). Birdsboro Steel Foundry and Machine Co.

(3) Industrial Elevators

A 36-page booklet on elevators and cranes has just been issued. These low-priced portable elevators are available in three standard models of 500, 1000 and 2000-lb capacity. They are designed to meet a wide range of portable elevator requirements, and have already found many applications. The bulletin also presents the entire line of Barrett elevators, hand-operated types with load capacities up to 5000 lb, and lifting heights up to 36 ft; electric-operated portable types with capacities up to 5000 lb; hand and electric telescopic portable types; barrel and drum elevators, including tilting models; pallet elevators; four-post types; platform loading and balcony elevators; revolving base types; and floor-to-floor elevators. Barrett portable cranes with fixed or revolving base, and hand and electric hoists are also shown. The characteristics of these elevators are illustrated in detail, including their safety features; the cable safety device, protected sheaves, the thermal overload switch, slack cable switch, automatic hinges, fully enclosed gears, grooved cable drum, direct connected motor, and arc-welded construction. (4951). Barrett-Cravens Co.

(4) Radiant Gas Burners

Industrial heat processing techniques with radiant gas burners that beam high temperatures to materials at the speed of light are described in a new bulletin just released. Accelerated heating of materials is accomplished by the effective use of radiant heat developed in burning compacted gas-air mixtures against cup-shaped refractory surfaces. The placement and throttling ranges of these radiant ceramic burners permit the controlled transfer of heat in patterns that meet most heat processing requirements. Selas radiant burners are being used for continuous tinplate fusion annealing metal and glass, baking enamels, drying inks, textiles and paper. Also, they are used in ceramic kilns, large-production steel mill installations, petroleum refineries and chemical plants. (S-1.1). Selas Corp. of America.

(5) Compressors

A "New Look" and a new idea in air-compressor design has been incorporated in a new line of modern, packaged-type, heavy-duty electric-driven compressors described in a new catalog. Sizes range from 125 to 350 hp for continuous full-load service and two-stage compression to 80-125 psi discharge pressures. Designated as the XLE, this completely new L design embodies a single vertical low-pressure compressor cylinder, a horizontal high-pressure cylinder, and a synchronous motor mounted directly on the crankshaft. It requires only a very small foundation, and is engineered full of new ideas from the inside out. one innovation is "Pipeless, Thru-Frame Air Flow." Air enters and leaves the compressor through main air connections on the frame, instead of on cylinders, and is led to and from both cylinders and intercooler through large passages within the frame itself. Counterflow, tube-and-finned construction of the intercooler is said to give excellent cooling with very little pressure loss and a small quantity of water. All bearings in the XLE are full-floating and rotate freely both on the bearing journal and within the rod or bearing housing. Main and crankpin bearings are of aluminum alloy. (3150). Ingersoll-Rand Co.

(6) Material Handling Catalog

A new catalog is available which describes equipment for handling bulk material such as coal and stone. The catalog is illustrated with photographs of installations actually made. It includes information on conveyors, car retarders, drives, elevators, pumps, screens and valves. (501). McNally Pittsburgh Manufacturing Corp.

(7) Redesigned Coupling

The Falk "Airflex" coupling has recently been redesigned after ten years of outstandingly successful service in the most difficult coupling applications. Improvement in rubber composition and bonding have increased the torque capacity 20 per cent above previously published values while the hubs and adaptor plates have been redesigned to facilitate disconnection and removal of the entire gland assembly. Redesigned components are entirely interchangeable with the equivalent components of all "Airflex" couplings now in use and standard parts may be combined to allow six different mounting arrangements including flange mounting on a flywheel. Stiffness factors can be controlled and are available for torsional analysis. This coupling is designed primarily for engine drives and for applications involving extremely severe torque fluctuations. (8100 and 8105). Falk Corp.

(8) Vibration Control Materials

Characteristics of the various types of vibration isolation media — springs, rubber, and cork materials — are given in a new bulletin, just released. Fifty typical machine and equipment applications are tabulated with recommendations for proper types of vibro-isolators for highest efficiency, and with alternates for satisfactory operating efficiency for less exacting requirements. Various types of standard mountings are described with data or loading ranges which run from 10 lb for small isolators to 50,000 lb per isolator for a heavy duty spring type. Specific purpose isolators for business machines, fan and motor units and other applications are also described. Typical specification clauses for installation contracts are also given. (G-102). Korfund Co., Inc.

(9) Turret Trucks

Five models of Hyster Salsbury turret trucks, formerly manufactured by the Salsbury Corp. of Los Angeles and now taken over by the Hyster Co., are pictured and described in an eight-page catalogue just released. Included in the turret line for horizontal materials handling are platform, pallet and cargo trucks as well as tugs and auto-loaders. Powered by a Wisconsin air-cooled engine, traveling up to eight miles per hour when fully loaded, and highly maneuverable, each truck is equipped with the Salsbury fully automatic clutch and transmission. The operator may either ride in a standing position or walk alongside, regulating speed by means of a throttle ring located inside the steering wheel. Turret trucks will handle almost any type of load up to a capacity of 4000 lb. (1138). Hyster Co.

(10) Metal-Cleaning Guide

The publication of a 44-page booklet, which reviews metal cleaning in all its phases, is announced. After considering briefly the wide variety of soils — oil, grease, rust, heat-scale, smut, tarnish, forming compounds, buffing compounds, rust preventives, metal dust and shop dirt — which result from fabricating operations such as heat-treating, forging, rolling, stamping, drawing, extruding, spinning, grinding, machining, buffing, etc., the booklet discusses specific materials, equipment and procedures for most effective removal of these soils. The booklet also offers helpful recommendations for improving the effectiveness of metal-cleaning operations in hard-water areas; for anti-rust protection of parts in production and during storage; on coolants and lubricants for machining and grinding; on simplified paint-stripping methods; and on treating wash water in paint-spray booths. (7790). Oakite Products, Inc.

(11) How to Use Aluminum Paint

A comprehensive, 32-page brochure for industrial users of aluminum paint is available. The new ALCOA publication points out that while the company does not make or sell aluminum paint, it feels obligated to explain how aluminum paints can be used to best advantage. The booklet emphasizes that uses of aluminum paint by business and industry fall into three classifications: 1. For metal, concrete and masonry and similar non-absorbant surfaces; 2. For weather-exposed wood; and 3. For interior heated surfaces and for decorative uses. Profusely illustrated, the book uses thirty photographs to show proven applications of aluminum paints over the years, ranging from oil refineries and coal tipples to industrial fencing and bridges. Several pages are devoted to questions and answers and an aluminum paint coverage table. (AD-228). Aluminum Co. of America.

(12) Multiple Rotary Slitting Lines

A new 76-page book on multiple rotary slitting lines is available to you. This book, briefly, traces the evolution of multiple rotary slitters and explains basic considerations in selection of equipment. Tables of production records show influence of slitting speed; coil sizes; number of strands slit, and coil handling equipment, on production of slit strands per cycle and per day. Against a background of information on production rates, general data on cost of equipment and operating cost, the advantages enjoyed by fabricators doing their own slitting are analyzed, including economics as well as reduction and simplification of inventories and production planning. Other subjects discussed include training of operators and their influence on output; advantages of feed rolls; techniques and equipment for slitting pre-finished or pre-coated stock without injury to the finish; slitting very narrow strands; methods of determining size of slitting line units for any given set of requirements, and minimum tonnages required to make slitter operation profitable. The book further illustrates standardized sizes of Yoder slitters, uncoilers, recoilers, scrap choppers, and coil cars, with brief specifications, capacity tables, etc. (5497). Yoder Co.

(13) Hot-Process Water Softeners

A particularly comprehensive bulletin on the most recent developments in hot-process water softeners is now available. An introductory section of the bulletin concisely explains the boiler plant troubles caused by various impurities in water, outlines the twelve different methods of treating water to eliminate these impurities, describes the reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. The two basic designs and the operation of Graver hot

process softeners are fully described, together with six adaptations of each design to various plant conditions, such as per cent make-up, treatment of condensate, deaeration required, etc. Methods of supplementary hot phosphate treatment are also explained. Sections of the bulletin are devoted to the latest advances in methods and designs of chemical feeders, and also filters and hot process softener accessories. The bulletin contains more than 30 diagrams of hot process designs and flow charts, together with many photographs of Graver installations of various sizes and types of units. (WC102) Graver Water Conditioning Co.

(14) Turbines for High Pressure Service

A new bulletin contains a complete description and specifications of a new single stage mechanical drive turbine suitable for pressures to 1450 psi gauge, initial temperatures to 950 F total temperature and back pressures to 300 psi gauge. The CP turbine is the first standard single stage mechanical drive turbine to be designed especially for high pressure service. The labyrinth shaft seal used in the CP turbine consists of a series of shaft grooves and mating tongues of stainless steel packing. The number of labyrinths in the shaft depends upon the exhaust pressure rating—as many as 52 labyrinths per side being employed for the highest pressures. This prevents leakage effectively, reduces losses, lasts longer and requires less maintenance. To provide for extreme thermal expansion encountered in high temperature service, the turbine is supported at the true centerline and the front end is mounted on a flexible channel. This method of mounting permits both radial and axial expansion to take place without disturbing the shaft centerline. The turbine can be furnished with any of eight different types of governors to meet all control requirements. They include: mechanical shaft, vertical flyweight with or without oil relay, hydraulic with or without oil relay, pressure governors for pump and blower drives and auxiliary tripping devices. A separate trip operating independently of the governing system gives positive protection against overspeeding. The CP turbine is made in three sizes for capacities up to 2000 hp. (4215). De Laval Steam Turbine Co.

(15) Shear Knife Handbook

The "Shear Knife Handbook," published recently by Heppenstall Co., is a 48-page, 4½ in. by 7¼ in. glossary of useful information for those who specify, use, buy or grind metal-cutting shear knives. Inside its red cover is a brief history of the company's background in shear knife manufacture; pertinent comment on current research and development of new knives, and a grade listing of the company's shear knives. Recommendations are given for selecting the correct grade knife for the cutting to be done, and tips are presented to facilitate inquiries and the handling of orders. The handbook is well illustrated and also contains utilization data on Heppenstall galvanizing and tinning rolls, composite back-up rolls, automatic materials handling tongs and C-Hooks. The booklet is completed by the inclusion of charts to calculate coil weight, tables for converting millimeters into inches, hardness conversion tables, and decimal equivalents. Heppenstall Co.

(16) Corrosion Service Piping

A new bulletin, "Corrosion Service Piping," is a comprehensive treatment on stainless steel and nickel alloy anti-corrosion and anti-contamination piping. Economics, standards, advantages of welding, extensive technical data, design tips, and complete dimensional information on stainless fittings and flanges are included in the 32 page, profusely illustrated bulletin. The bulletin is particularly interesting and valuable at this time as the American Standard for Stainless Steel Pipe, ASA B36.19-49, has just been adopted by the American Standards Association. The bulletin was prepared with B36.19 as its basis and it contains a comprehensive discussion and explanation of the importance of this standard. (485.) Taylor Forge and Pipe Works, Inc.

(17) Open Hearth Burners

A bulletin is available describing a new development in burners for open hearth furnaces. These burners are said to materially reduce erosion of brickwork and increase roof life because the artillery burners are designed for individual furnaces in which they are to be used. These burners do not require protective brickwork. The bulletin tells how doghouse elimination not only reduces brickwork, but prevents turbulence in the end of the furnace, thereby reducing the burning out of end walls. Crowe Engineering Co.

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50	AIR REDUCTION SALES CO.		A hardfacing alloys catalog is available on Airco's complete line of "wear-resistant" alloys.
51	ASKANIA REGULATOR CO.	BULLETIN 139.	This bulletin offers solutions to your control problem.
52	BAILEY METER CO.	BULLETIN 239-C.	Gives the full story on Pyrotron electronic resistance thermometers.
53	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes.
54	BLOOM ENGINEERING CO., INC.		Bulletins available on engineered combustion equipment
55	BRANDT, INC., CHARLES T.	REFERENCE FILE NO. 509.	A fingertip file of metalworking information is available.
56	BROWNING AND CO., INC., VICTOR R.	BULLETIN "S".	Describes Browning mill type cranes.
57	CLEVELAND WORM AND GEAR CO.	CATALOG 300.	Full description is available on Cleveland's worm-gear speed reducers.
58	COLUMBIA ELECTRIC MANUFACTURING CO.	CATALOG IS-700.	Gives complete details on motor generators.
59	CRANE CO.	CATALOG 49.	Data available on Crane's piping systems.
60	CROCKER-WHEELER DIVISION, ELLIOTT CO.	BULLETIN SL-620-1.	Bulletin describes Crocker-Wheeler auxiliary mill motors.
61	DE LAVAL STEAM TURBINE CO.	CATALOG 10-16.	Describes the features that one should investigate before buying a centrifugal pump.
62	ELECTRIC CONTROLLER AND MANUFACTURING CO.	BULLETIN 1190.	Gives details of the short-throw, narrow width cam master switches.
63	ELECTRIC STORAGE BATTERY CO.		"Exide-Ironclad Topics" contains latest developments in materials handling.
64	FARREL-BIRMINGHAM CO., INC.	BULLETIN 115.	Describes in detail the many features of the Farrel heavy duty roll grinder.
65	FAWICK AIRFLEX CO., INC.	BULLETIN 300.	Specific information available on all advantages of Fawick clutch and brake units.
66	FURNACE ENGINEERS, INC.		Bulletin available on F.E.I. galvanizing furnaces and equipment.
67	GENERAL ELECTRIC CO.	BULLETIN GEA-3758.	Contains full data on the G-E unit substations.
68	HARNISCHFEGER CORP.	BULLETIN C-39.	Describes P&H Magnetorque control.
69	HEPPENSTALL CO.		Booklet available describing Heppenstall's automatic Safe-T-Tongs.
70	HOMESTEAD VALVE MANUFACTURING CO.	BOOK 38.	Valve reference book tells how to eliminate costly shutdowns.
71	JONES FOUNDRY AND MACHINE CO., W. A.	CATALOG 70.	Contains the method of selecting speed reducers.
72	LEEDS AND NORTHRUP CO.	CATALOG N-33B.	Gives the full story on all Rayotubes.
73	LESLIE CO.	BULLETIN 461.	Describes the Leslie Class LT-3 reducing valve.
74	LINTERN CORP.	BULLETIN AC 4912.	Explains the features and economics of the aire-rectifier.
75	MAGOR CAR CORP.		"The Answer to High Refuse Disposal Costs" explains the many money-saving advantages of owning Magor air dump cars.
76	OAKITE PRODUCTS, INC.	FOLDER F7338.	Gives details on the Oakite steam gun.
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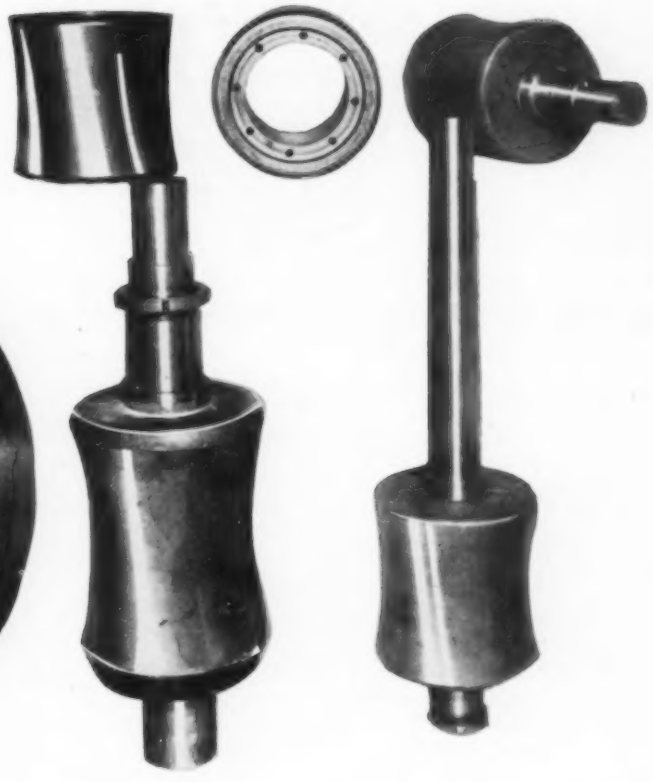

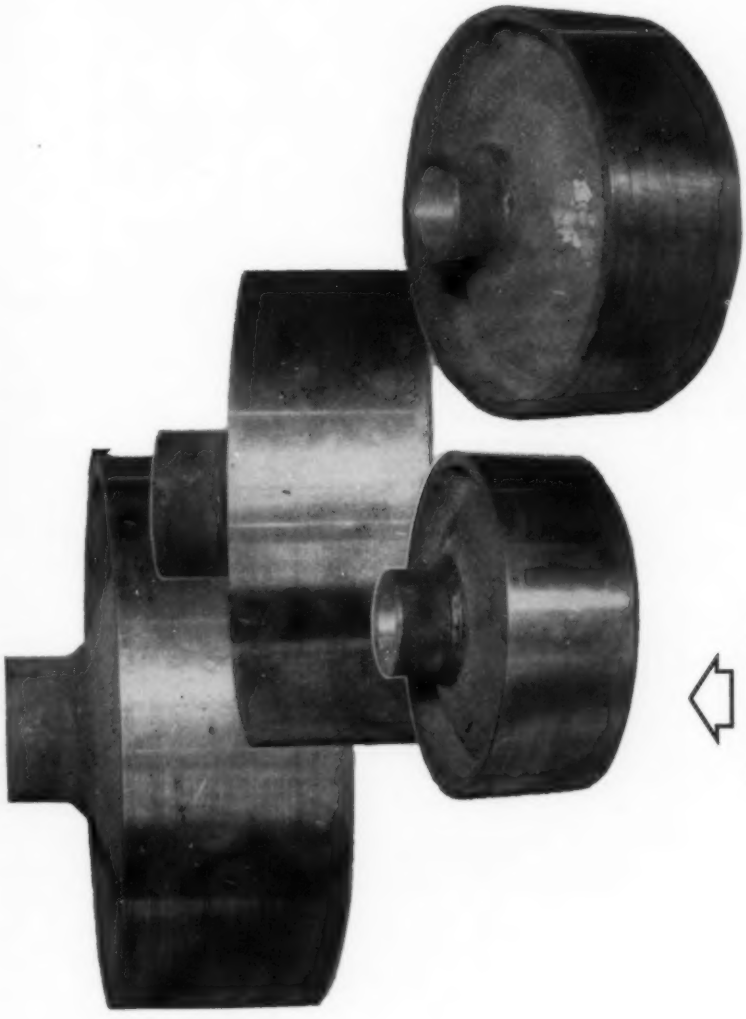

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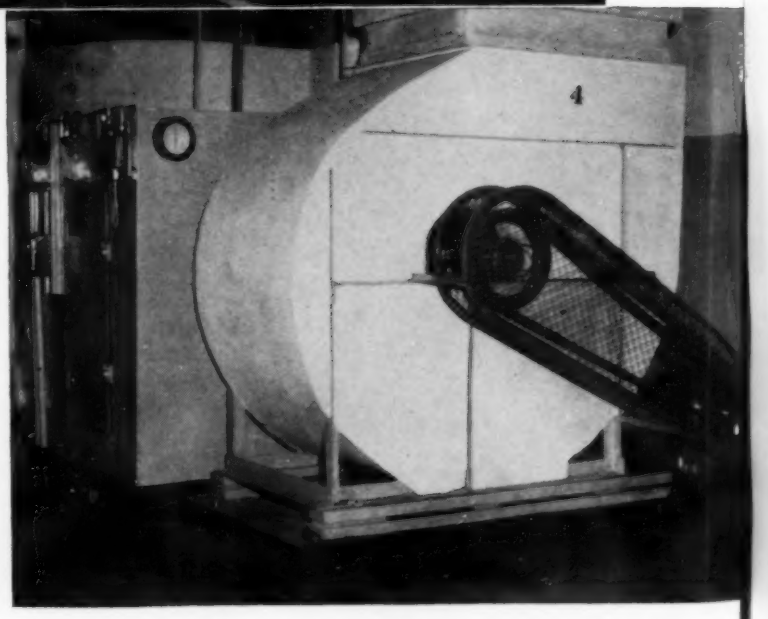

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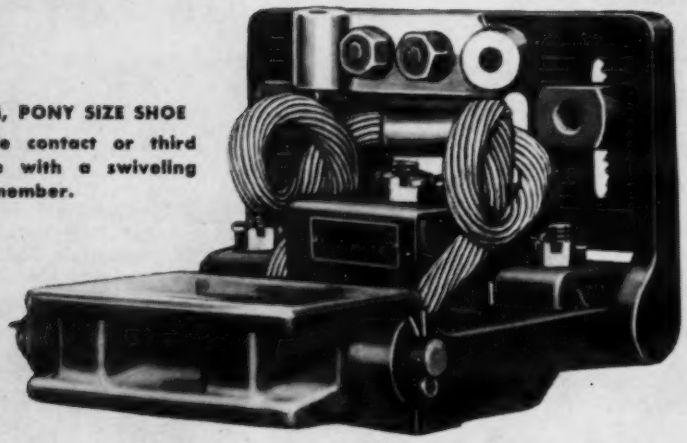

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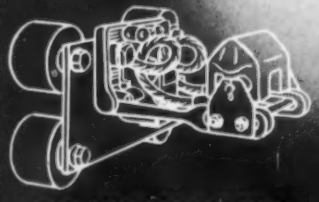
Reversible contact or third rail shoe with a swiveling contact member.



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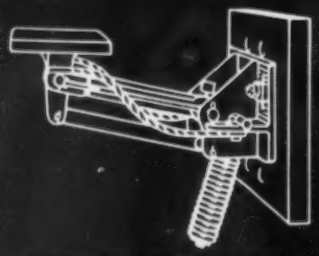
Four insulators; 2" horizontal movement. Other types of special contact shoes also available.



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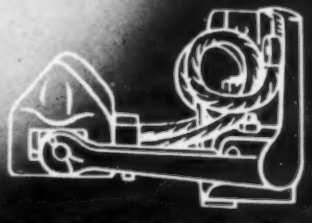
. . . *flexible cables!* Flexible copper connection cables link the upper bronze connecting block direct to the contact member. The design of the cable terminal lug allows feeder cables to enter the top or the side.

There is a Keystone Contact Rail Shoe to meet every requirement of steel mills. For complete information write for "Keystone Industrial Products."



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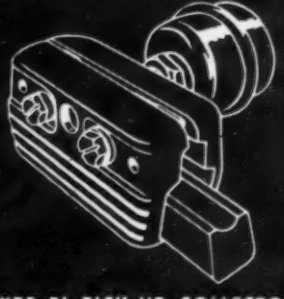

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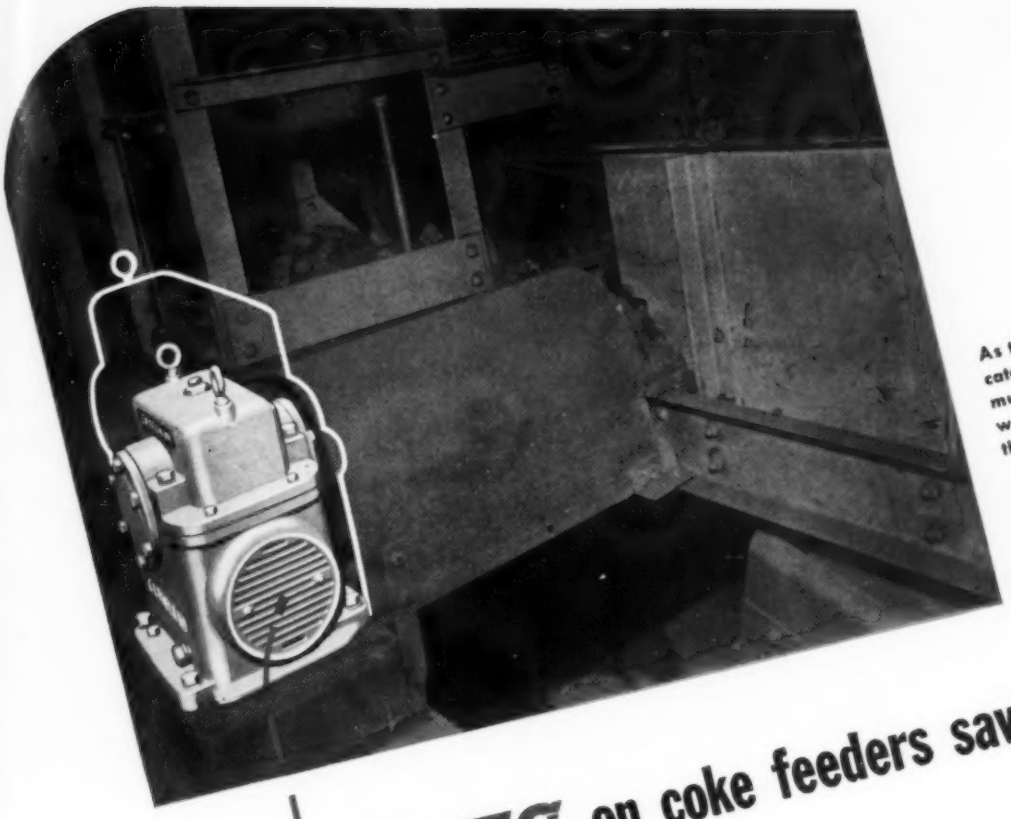


As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

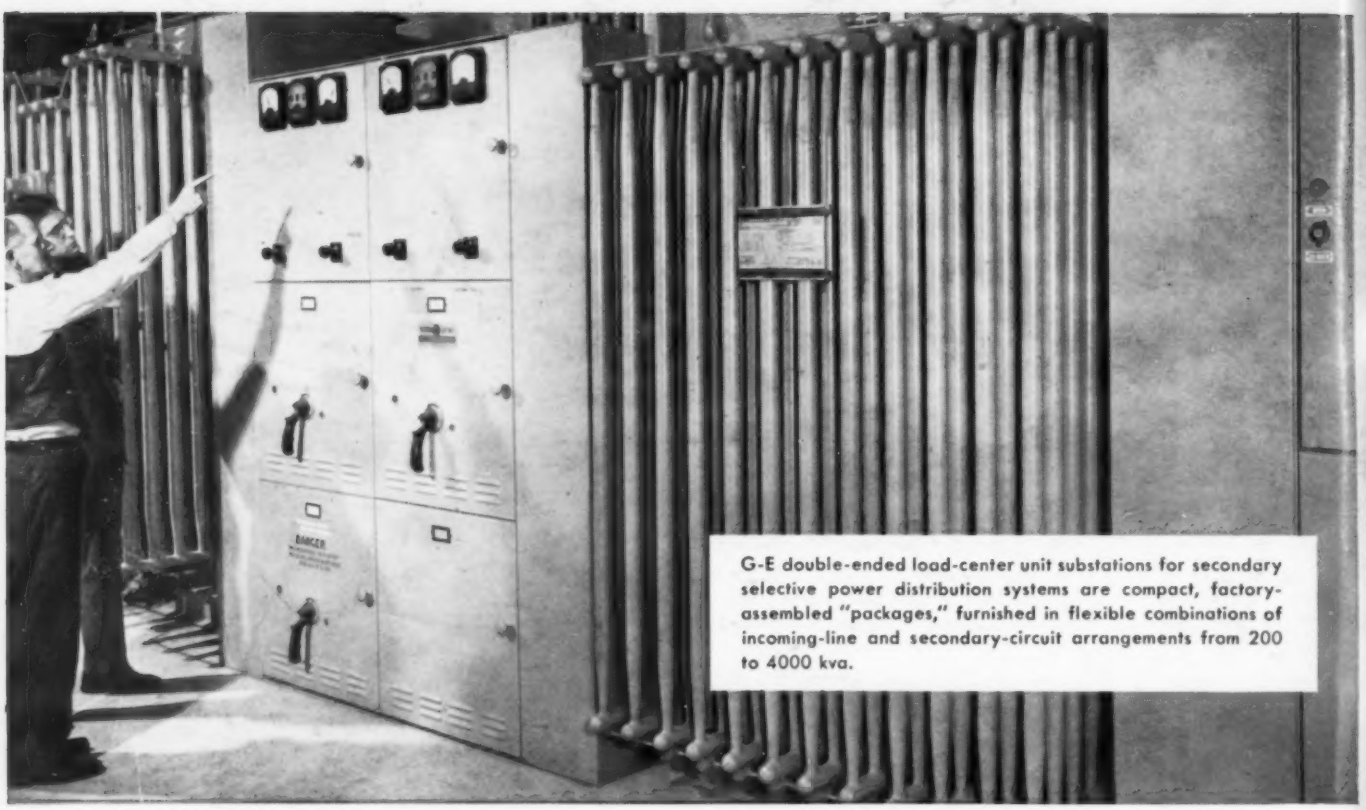
SPEEDAIRES on coke feeders save 53% of space

SAVING space was a prime consideration in this installation of 3 Speedaires—driving coke feeders in an Ohio blast furnace stock house. The Speedaire units, one of which can be seen here, occupy less than half the space required by standard worm gear drives of comparable capacity. In addition, use of Speedaire effected a weight reduction of 825 pounds and saved the steel company $390.00 on installation cost.

Speedaire is Cleveland's fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands. For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3278 East 80th St., Cleveland 4, Ohio.

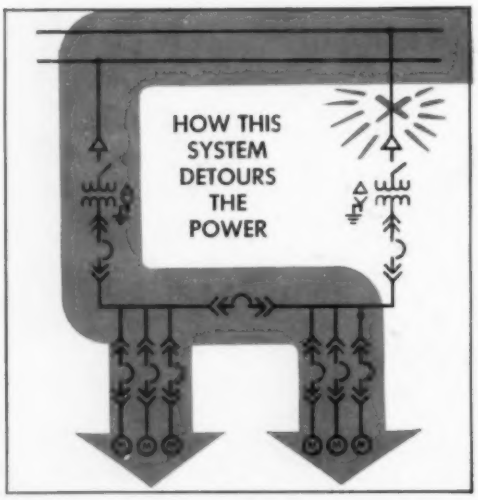
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers



G-E double-ended load-center unit substations for secondary selective power distribution systems are compact, factory-assembled "packages," furnished in flexible combinations of incoming-line and secondary-circuit arrangements from 200 to 4000 kva.

G-E Unit Substations keep steel-making "on the go!"



As this simplified diagram shows, an alternate power source for secondary circuits is provided by closing the tie circuit breaker between the secondaries of two transformers. Thus, if a primary-circuit fault de-energizes one transformer, essential load is detoured to the other, and important production keeps going.

Secondary selective feature provides alternate route for power—protects service continuity

Here's a low-cost way to safeguard service continuity in steel mills: distribute your plant power through a secondary selective power system using General Electric double-ended or pairs of single-ended unit substations. By providing two separate power sources for every secondary, this method in effect permits detouring essential loads from one transformer, temporarily out of service, to its working partner.

Simplicity and safety are other advantages of this system. No special training is needed to operate and maintain the equipment contained in a G-E load-center unit substation. All units are completely metal-enclosed to protect operating personnel.

Moreover, expansion is easy and economical. Single-ended or double-ended unit substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GEA-3758. Send today for your copy. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

For helpful, cost-cutting ideas, see "Modern Industrial Power Distribution," a More Power to America slidefilm in full color and sound. Your G-E representative will gladly arrange a showing.

GENERAL ELECTRIC

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